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THESIS

**ANALYZING AND SHARING DATA FOR SURFACE
COMBAT WEAPONS SYSTEMS**

by

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December 2004

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SYSTEMS**

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ABSTRACT

Test and evaluation of system performance has been a critical part of the acceptance of combat weapon systems for the Department of Defense. As combat weapon systems have become more complex, evaluation of system performance has relied more heavily on recorded test data. As part of the ongoing transformation of the Defense department, Commercial-Off-The-Shelf (COTS) technology is being integrated into the acquisition of combat weapon systems. An Analysis Control Board (ACB) was created in response to these factors to support the AEGIS Weapon System Program Office. The focus of this ACB was to investigate and provide potential solutions to Data Dictionary, Data Recording and Data Reduction (R2D2) issues to the AEGIS Program Manager. This thesis discusses the history of the R2D2 ACB and its past, present and future directions. Additionally, this thesis examines how the R2D2 ACB concept could be applied to the DD(X) Next Generation Destroyer program.

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LIST OF ACRONYMS AND ABBREVIATIONS

AOA – AEGIS Open Architecture
ACB – Analysis Control Board
ADS – AEGIS Display System
ASNE – American Society of Naval Engineers
ATES - AEGIS Tactical Executive System
ATES/43 - AEGIS Tactical Executive System for the AN/UYK-43
AWS – AEGIS Weapon System

C&D – Command and Decision
CEC – Cooperative Engagement Capability
CLSE – Closed Loop System Engineering
CNO – Chief of Naval Operations
CO – Commanding Officer
COTS – Commercial-Off-The-Shelf
CSEDS – Combat Systems Engineering Development Site
CSC - Computer Sciences Corporation
CSSQT - Combat Ship System Qualification Trials

DX – Data Extraction
DR – Data Recording
DT - Developmental Test
DX/DR – Data Extraction/Data Recording

EP - Extraction Point

IPT - Integrated Product Team
ISEA - In-Service Engineering Agent

LM – Lockheed Martin
LM MMS - Lockheed Martin Maritime and Marine Systems

MIL-STD – Military Standard
MEIT – Multi-element integration testing

NCW – Network Centric Warfare
NGMS – Northrop Grumman Mission Systems
NSWC – Naval Surface Warfare Center

OA – Open Architecture
OPNAV - Chief of Naval Operations Staff
OT - Operational Test

PEO – Program Executive Office
PEO-IWS – Program Executive Office Integrated Weapon Systems
PM – Program Manager

R2D2 – Data Dictionary, Recording and Reduction

SEC – System Engineering Council

TAO – Tactical Action Officer

T&E – Test and Evaluation

TOR – Test Observation Report

WCS – Weapon Control System

WSPA - Weapon System Performance Assessment

WSPR - Weapon System Performance Reviews

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EXECUTIVE SUMMARY

Test and Evaluation is a critical part of the procurement of military systems and analysis of test data is required to determine if the system performance met the defined requirements. In an effort to ensure that the test data from formal acceptance tests, such as Ship Qualification Trials, Developmental and Operation Tests was adequate for analysis, an analysis control board (ACB) was formed to address Data Dictionary, Recording and Reduction (R2D2) issues. The R2D2 ACB has supported program managers in the AEGIS program office by investigating and providing technical expertise for Data Dictionary, Recording and Reduction issues. The R2D2 ACB is a proactive effort sponsored by the AEGIS program office to resolve issues that will affect the evaluation of formal acceptance testing before the tests are executed. Resolving issues prior to formal acceptance testing significantly reduces the risk of requiring a test to be re-executed. As the Defense Department transforms itself to meet future missions, this study examines Defense Transformation and SEA POWER 21 to determine how the R2D2 ACB can change to meet the challenges of the future.

Changes in the design of military systems, specifically the implementation of Commercial-Off-The-Shelf hardware, have provided significant challenges to the recording and analysis of test data from the AEGIS Weapon System. As the AEGIS Weapon System completes the transition to Open Architecture, the challenge of assessing system performance will become even greater. This study includes an analysis of the DD(X) Next Generation Destroyer program and how the concept of the R2D2 ACB can be applied to this program.

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I. INTRODUCTION

A. BACKGROUND

During the early development of the AEGIS computer program, data was recorded in a defined format called AEGIS Tactical Executive System for the AN/UYK-43 (ATES/43)¹, or more commonly referred to as ATES. The function of data recording is to provide an objective set of information to evaluate system performance. Historically, the AEGIS program has recorded data in a binary format with the ATES format providing a “data recording function, which provides the means for extracting selected main memory resident data from tactical computer programs and for recording this data on media (optical disk or magnetic tape) for subsequent reduction and analysis.” (“Program Performance Specification”, 1999, p. 1-1) ATES was customized to allow the data to be captured from the unique, military standard hardware. This recording method focused on dumping data that was recorded in specific, defined, hard coded memory locations. Since the hardware was military standard (MIL-STD) and non-commercial, this method proved effective within the constraints of non-commercial hardware and software. The mission of ATES is defined “... as a subsystem within each of the combat system computer programs listed ... to provide for each of them an environment within which they can achieve their individual missions, and can work together to achieve the mission of the Combat System. This environment provides the ability for a program module to communicate with other program modules and data internal to the AN/UYK-43, the AN/UYK-43 hardware, and, via this hardware, the devices outside the AN/UYK-43.” (“Program Performance Specification”, 1999, p. 1-1) The data recording function was designed into the system during development providing an inherent advantage to later systems for event reconstruction but it was tied to

¹ The ATES data-recording format was designed to be used with MIL-SPEC computers by the AEGIS program. DXR was introduced with the insertion of COTS computers into the AEGIS Weapon System. ATES and DXR format the data received from the AWS and write the data in a binary format to a storage media, generally a digital tape or optical disk. When this data is extracted from the storage media, a data dictionary is used to reconstruct the data into the appropriate fields of information.

customized, MIL-STD hardware. ATES had some very specific capabilities embedded into the design of the data recording function including controlling application program module execution, fault tolerance to recover from all single point failures, support inter-computer communications and the data environment including data recording. (“Program Performance Specification”, 1999, p. 1-1)

In the early development of the AEGIS Weapon System, data recording and extraction was a critical component of the development. The system designers and integrators relied upon the data extraction to determine system performance and specification compliance. However, data recording is not unique to the AEGIS program. Data recording and extraction is critical to test and evaluation events in order to determine whether the system performance was acceptable. Whether the data is recorded on a local disk drive or captured by telemetry from a satellite, the ability to reconstruct system performance is critical to determining if the mission was successfully accomplished.

Baseline migration to Commercial-Off-the-Shelf (COTS) technology presented numerous data extraction/data reduction (DX/DR) challenges. A meeting was held at the Combat Systems Engineering Development Site (CSEDS), Moorestown, NJ on 25 July 2001 to discuss DX/DR issues associated with AEGIS Display System (ADS) Mark 6 and AEGIS Weapon System (AWS) Baseline 6 Phase 3. The discussion was focused on identifying current data extraction and reduction (DX/DR) short falls, assessing their impact on upcoming test events, and ensuring a solid plan was in place to correct discrepancies. Two major areas of ADS Mark 6 concerns were presented,

1. Inability to perform complete event reconstruction at ADS and
2. Data dictionary deficiencies limit the ability to reconstruct a complete set of console operator actions, operator alerts and doctrine.

Cooperative Engagement Capability (CEC) provided the first at-sea developmental testing for the ADS Mark 6 aboard the USS HUE CITY and USS

VICKSBURG. The at-sea testing resulted in a large number of high priority issues. The lack of DX/DR capability for ADS Mark 6 was overshadowed as a result of the multitude of problems. The limited time and resources that were available at this time were devoted to developing the tactical baseline code that was viewed as the highest priority. As such, data analysis capability in ADS Mark 6 received a low priority during the two years of shipboard testing. While an ADS Baseline 6 Phase 1R data dictionary was provided during the later phases of Cooperative Engagement Capability (CEC) testing, enumerations to interpret numeric data were not provided, precluding meaningful analysis from being accomplished. Since there are no Extraction Points (EP) in ADS data dictionary for the track database corresponding the data displayed at the ADS consoles, complete reconstruction of tactical events as they were processed by key watch standers (e.g. Commanding Officer (CO), Tactical Action Officer (TAO)) at all Q-70 consoles was not possible. The lack of complete reconstruction of the tactical picture was a departure from the previous ATES baselines. The impact of this condition varies in severity according to the implementation of ADS in each particular baseline. Recent AEGIS baselines have captured some of this lost capability.

Since the implementation of COTS technology for AWS was a phased approach, the analysis community realized that the problems faced with ADS were a precursor to similar problems that could result in the COTS implementation of the other elements of AWS. The length of production runs for COTS components is significantly shorter than the comparable MIL-SPEC components historically used in the AWS. The result of this was differing performance among equipment within the same AEGIS baseline. Additionally, the differences in COTS implementation between Cruisers and Destroyers resulted in multiple variants of the same AEGIS baseline. Different configurations within the Destroyers resulted in variants within the AEGIS Destroyers for Baseline 6 Phase 1. The spawning of multiple variants of the

AEGIS baselines resulted in large efforts to make the tactical computer programs ready for test and resulted in a resource limitation for non-tactical areas including data recording and extraction.

While the problems with the ADS data recording provided the groundswell of concern that launched the Data Dictionary, Recording and Reduction Analysis Control Board (R2D2 ACB), the R2D2 ACB evaluates issues with recorded data for the SPY-1 radar, command and decision (C&D) and weapon control systems (WCS) as well. An analysis control board (ACB) is a technical working group that is chartered to deal specifically with data analysis issues. The ACB meetings are scheduled based upon the testing schedule and number and priority of outstanding issues. During the year 2003, the R2D2 ACB met approximately once every two months. Participants in the ACB included Naval Sea Systems Command, Naval Surface Warfare Centers (Corona, Dahlgren and Port Hueneme Divisions), Lockheed Martin, Northrop Grumman Mission Systems and others.

The R2D2 ACB is part of the closed loop system engineering process that is used by the AEGIS program. Within this format, the R2D2 ACB reports to the program manager and is available to support the system engineering councils as required. The Closed Loop System Engineering process as implemented in the AEGIS Program is illustrated in Figure 1.

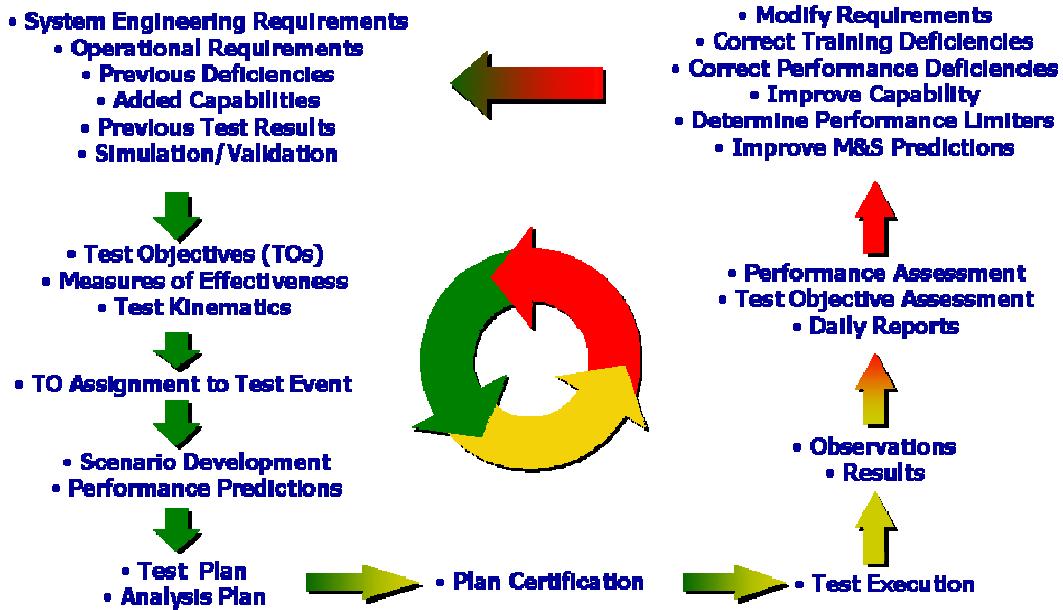


Figure 1. Closed Loop System Engineering Process.

(Sparks, 2001)

In this closed loop system engineering (CLSE) process, system engineering requirements, operational requirements, deficiencies, new added capabilities, previous test results, and simulation/validation issues are evaluated. Test objectives are created to ensure that the following areas are properly analyzed. Measures of Effectiveness specify how each test objective is assessed and includes test kinematics, such as the required sequence of events, system settings, and target needs. Test objectives are assigned to specific test events. Test scenarios are developed to meet the objectives. Modeling and Simulation studies are performed to predict the expected outcome of each test scenario. Next, the requirements to execute the test scenarios are documented in the test plan. The test plan is required to complete a certification process that is completed about three months prior to the beginning of testing to allow sufficient time for test scenario preparations. During the CSSQT testing, the test scenarios are executed and the test data is collected and delivered to the analysis. Test objectives are assessed and performance issues become part of the Weapon System Performance Assessment (WSPA) process. Together, test objective assessment and the WSPA process feedback into the process,

resulting in modification of requirements, correction of training and performance deficiencies, capabilities improvements, determination of performance limiters, and improvement of M&S models. The test results are then fed into new test objectives and the closed loop system engineering process continues on. The R2D2 ACB is part of the assessment, reporting and system engineering requirements functions of this closed loop system engineering process.

B. PURPOSE AND RESEARCH QUESTIONS

The purpose of this study is to explore the lessons learned from the R2D2 ACB and the value, if any, that it provides. This study will investigate the potential value that this type of forum can provide to other military weapon systems. The following research questions have been formulated to explore R2D2 ACB efforts and potential future directions.

- Has the R2D2 ACB provided value to the AEGIS program?
- What changes, if any, can be incorporated into the R2D2 ACB using best practices available today?
- Is the Navy able to spend sufficient time supporting R2D2 issues?
- What level of effort is required to successfully institute an R2D2 ACB and what level of support does the management/leadership need to provide for the ACB to provide value to each participant's activity?
- Can the R2D2 ACB concept be applied to the DDX program?
- Can the R2D2 concept be applied to AEGIS Open Architecture?

C. STAKEHOLDER INFORMATION

There are many stakeholders in the R2D2 ACB. Each stakeholder is listed below with a brief description:

- **Naval Sea Systems Command (NAVSEA) Program Executive Office Integrated Warfare Systems (PEO-IWS):** Program office responsible for assignment of tasking. PEO-IWS 1A1B has oversight of the R2D2 ACB for the AEGIS program.
- **Naval Surface Warfare Center (NSWC), Corona Division:** Tasked to be the independent assessment agent for NAVSEA/PEO-IWS 1A.
- **Naval Surface Warfare Center, Dahlgren Division (NSWC DD):** Responsible for AEGIS computer program certification.
- **Naval Surface Warfare Center, Port Hueneme Division:** Performs the In-Service Engineering Agent (ISEA) function.
- **Computer Services Corporation (CSC):** Responsible for developing computer code for the AEGIS program.
- **Lockheed Martin Maritime and Marine Systems (LM MMS):** The prime contractor and design agent for the AEGIS program.
- **Combat Systems Engineering Development Site (CSEDS):** Government owned facility where AEGIS computer program baselines are tested and functionality is demonstrated.
- **Northrop Grumman Mission Systems (NGMS):** Contractor that supports the AEGIS program. NGMS has offices in Washington, DC to support the Program Office at WNY and in Mt. Laurel, NJ to support CSEDS.

D. SURVEY QUESTIONS

It is important to ensure that a representative of each stakeholder respond to the survey to ensure that the results reflect a consensus view. There are many methods that can be used and will be discussed in section 3. The survey is designed to provide insight into answering the research questions.

E. SCOPE

The scope of this study will examine three specific areas: AEGIS Baseline 7 Phase 1, DD(X) platform and AEGIS Open Architecture (AOA). While the DD(X) platform is programmed to be an Open Architecture platform, it is unclear

as to the level of compatibility that the DD(X) and AOA implementations of Open Architecture will have.

The R2D2 ACB has come into existence out of necessity. However, since its inception, no effort has been undertaken to quantify the benefits that it provides. This study will attempt to quantify the benefits that the R2D2 ACB provides to the AEGIS program. A high level review of efforts involved in supporting the ACB will also be characterized and compared to those benefits. After this comparison is completed, the DD(X) and Open Architecture programs will be examined to determine if the benefits provided to the AEGIS program will continue to be benefits to these emerging programs. A potential scope of costs will also be examined for comparison to the expected benefits. This study will also provide a roadmap for support of future AEGIS baselines that are all programmed to have some level of AOA implementation.

F. BENEFITS OF STUDY

There are three readily identifiable benefits of this study. The first benefit is that the R2D2 ACB will have a roadmap for supporting future programs. The second benefit is that the R2D2 ACB will be able to evaluate its present practices to determine if improvements can be put in place. The third and most important benefit is that this study will validate the value provided by the R2D2 ACB or if value is not provided, a recommendation to cease operations will be made.

II. LITERATURE REVIEW

For this research study, a number of documents have been reviewed. Primary sources of information included R2D2 ACB presentations, meeting minutes and email messages. Additional sources included specifications, articles and selected publications.

A. PROGRAM REVIEW

1. R2D2 ACB

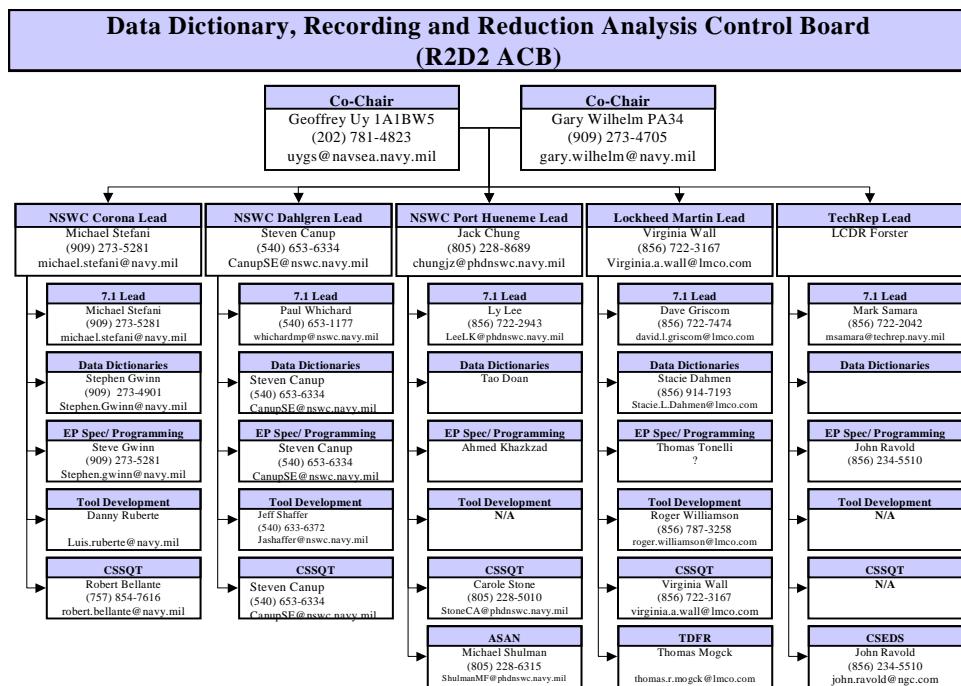


Figure 2. R2D2 ACB Organizational Chart.
(Gallagher, 2004).

An ACB is a technical working group that relies upon participation from the entire AEGIS data analysis community, which ultimately answers to the AEGIS

program Office. The ACB strives to obtain group consensus for issues that must be resolved. While group consensus is not always possible, most issues are resolved with group consensus. In cases where a group consensus is not reached, a majority and minority viewpoint are presented to the program manager for ultimate adjudication if necessary. The R2D2 ACB has experienced development stages experienced by most working groups and passed through the stages of Forming, Storming, Norming, and Performing as depicted below. One of the challenges of this ACB has been to avoid "paralysis by analysis" as the group is composed of analysts. By encouraging discussion and respect of all viewpoints, the ACB has been able to extend the Performing stage of its development. (DAU Program Managers Tool Kit, 2003)

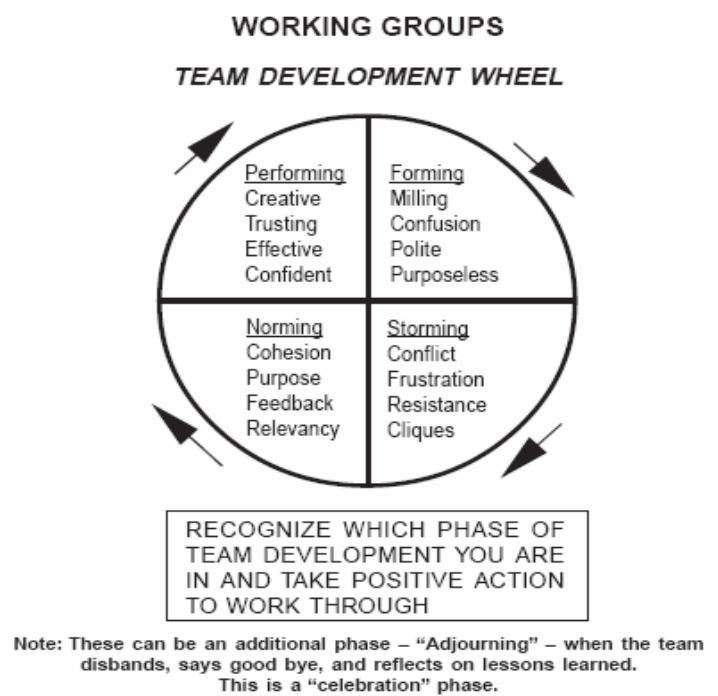


Figure 3. Working Group Model.

(DAU Program Managers Tool Kit, 2003, p.79)

2. Coordinating Multi-agency Testing and Satisfying Individual Organizational Requirements

In the development of the AEGIS weapon system, each computer program baseline requires a series of tests. The tests required could include: functional configuration, demonstration, multi-element integration, computer certification, combat ship qualification trial, development and operational testing. Each of these tests may have a subset of stakeholders within the ACB and occur at different stages in the computer program development. One benefit of participation in the ACB has been the opportunity for involvement of all of the participants in earlier stages of computer program development. The charter of the ACB allows for a feedback mechanism to the computer program developer and integrator while keeping the involvement focused on issues that provide the greatest value. Early on, the prime contractor (LM) realized that receiving feedback on data recording issues earlier in the computer program development would help problems to be fixed before formal test and evaluation events. While having optimal data recording is desired, a dynamic balance exists that requires consideration of development of tactical functionality versus analysis capability. Capturing the value provided by the improvements in analysis capability allows the program manager to determine whether the benefit provided is worth the required resource expenditure.

3. Selection of Team Members

Analysis Team Member selection is effectively controlled by the program manager and exercises control by the budgeting of program funds. The chairman of the ACB has considerable influence in the selection and retention of team members as well. Each organization that is involved in the ACB relies upon the program manager to provide funding for many tasks beyond the ACB. The funding control allows the program manager to determine the level of participation required from each organization. If the participation is insufficient,

the program manager can require an activity to provide additional members to support the R2D2 ACB. Similarly, if a participant is not supporting the efforts of the ACB, the program manager can have that member removed from membership in the R2D2 ACB.

4. Program Manager Support

For the ACB to be successful, the program manager must support the ACB. Reasons for this include funding and acceptance of ACB findings. Without program manager support, the ACB would not be able to get an adequate level of participation to uncover and evaluate data dictionary, data recording and reduction issues. Even if the issues are discovered and documented, the program manager needs to understand and prioritize resources to address each issue relative to its risk to the program.

5. Communication Methods

Communication methods vary from informal to very formal. ACB meetings are generally communicated by a generic email sent to a large number of participants and interested parties. More formal communication has occurred at AEGIS Weapon System Performance Reviews (WSPR) where the R2D2 ACB presents major findings and issues to the AEGIS community. A website is used to post information and meeting minutes regarding the ACB to allow participant to review past events.

6. Entrance Criteria

The entrance criteria for consideration by the R2D2 ACB is that a computer program baseline is under development and is entering or in the Test and Evaluation phase. The exit criterion is correspondingly, when the Test and

Evaluation phase is complete including operational testing and the required analysis reports have been submitted.

B. DETERMINATION OF STAKEHOLDERS

The program manager and the ACB chairman determine stakeholders. Any organization or person desiring to join the ACB can make a request to the program manager or ACB chair. All direct participants in the ACB are considered to be direct or indirect stakeholders by virtue of their ACB status.

C. ROLES AND RESPONSIBILITIES

The roles of the ACB fall into a few categories as listed below:

- **Program Manager:** Final authority on whether funding can be provided to remedy data dictionary, recording and reduction issues. Provides high-level interface to the program manager and executive management levels at the contractor and within the Program Executive Office.
- **ACB Chairman:** Responsible for determining issues that merit discussion and setting agendas. Reports directly to the program manager and provides a single voice representing the analysis community consensus on issues discussed. The chairman provides an objective view that does not favor any individual stakeholder or member.
- **Leader:** Each stakeholder activity designates a leader for their representation. The leader is expected to provide a consensus view for each issue for their activity. The leader is also responsible for ensuring that action items assigned to members from their activity are answered.
- **Participant:** A participant is someone who regularly or periodically attends ACB meetings. Their level of involvement varies from significant to spectator depending on issues that require discussion and action.

D. CURRENT EVALUATION PLAN

The AEGIS baseline managers evaluate the efforts of the R2D2 ACB and their support for ACB efforts is required for success. If the R2D2 ACB is not performing well, the baseline manager will not support the R2D2 ACB. Lack of participation by the baseline manager indicates to the contractor that the issues that the ACB surfaces are not important enough to warrant expenditure of significant resources. However, if the baseline manager is supportive and involved, the effort expended to remedy issues will increase as the contractor views the ACB as an extension of the program office.

E. IDENTIFIED RISKS / CONCERNS

1. Present Current Data Dictionary, Recording and Reduction Issues

The R2D2 ACB meets approximately once every two months to discuss and evaluate issues regarding data dictionaries, data recording and data reduction. If an issue cannot be resolved during the meeting, an action item is assigned to collect the information required for the ACB to make an informed decision on the importance of the issue and the potential risk that it may cause the program. The action items are tracked by the ACB until closed and the status is reported to the program manager. The combination of meeting minutes and action items provide a comprehensive list of all data dictionary, recording and reduction issues addressed by the ACB.

2. Team Effectiveness

As part of this research effort, a review of team effectiveness practices was conducted. While the R2D2 ACB is a technical working group, at a practical level, it must be able to consider the policy implications of the issues to be

presented to the program manager. The selection of A Practical Guide for Policy Analysis by Eugene Bardach was chosen to provide some insight and tools for this reality. This portion of the literature review details the eightfold path problem solving method. (Bardach, 2000, p. 1-46) The method steps are:

1. **Define the Problem.** Defining the problem should be evaluative and quantifiable. Find conditions that cause problems. Look for any opportunities that are being missed. Make sure that to avoid fitting a predefined solution into the defined problem and be skeptical when cause and effect are presented. (Bardach, 2000, p. 1-6)
2. **Assemble some Evidence.** Think about the value of the evidence before spending resources to collect it. Conduct a literature review and survey best practices to determine if any apply to this problem. (Bardach, 2000, p. 7-12)
3. **Consider Alternatives.** Model the system and stay focused on the problem as alternatives are evaluated. (Bardach, 2000, p. 12-19)
4. **Select Criteria.** When selecting criteria, think about judging the outcomes and determine how to weigh aspects such as efficiency, acceptability, improvement and robustness. (Bardach, 2000, p. 19-26)
5. **Project the Outcomes.** Projection = Model + Evidence. Estimate the magnitude of the outcome and consider where is the break-even point. Don't be too optimistic and remember to consider the undesirable side effects. (Bardach, 2000, p. 27-36)
6. **Confront the Trade-offs.** If a good job is done in step 5, there should be plenty of good choices of outcomes to try to optimize for a solution. (Bardach, 2000, p. 37-39)
7. **Decide.** If the results of these steps indicate that the project is not worth doing, then go back and revisit steps 1 through 6. Just because it hasn't been done before doesn't mean it isn't a good solution even if it seems too obvious. As Bardach wrote, "If your favorite policy alternative is such a great idea, how come it's not happening already? The most common source of failure on this test is neglecting to consider the resistance of bureaucratic and other stakeholders in the status quo". As changes are identified in a project, the bureaucratic and other stakeholders must be considered and how to achieve their buy-in to avoid and overcome resistance. (Bardach, 2000, p. 40-41)

8. **Tell your story.** Consciously avoid some of the common pitfalls which include: following the eightfold path without thinking it through, compulsive qualifying, show your work but stay focused on what is really important, listing without explaining will not help the readers and evaluators to understand your decisions, avoid a pompous insider's style. (Bardach, 2000, p. 41-46)

3. Project Management

The R2D2 ACB requires careful consideration of the management of projects. Visualizing Project Management by K. Forsberg, H. Mooz, and H. Cotterman (2000) provides the following practical advice in project management. Eliminating features from a proven template must be justified and to proactively manage a project requires an approach that is “orderly, methodical and disciplined”. (K. Forsberg, H. Mooz, and H. Cotterman, 2000, p. 77) During Combat System Ship Qualification Trials (CSSQT), the analysis of weapon system performance requirements must be balanced with the computer program development resources and the test and evaluation schedule before any changes are requested to the test events. The ACB is cognizant about trying to gain efficiency at the expense of eliminating a necessary function. The ACB function of conducting analysis acts as a control gate with reporting to the program office and numerous System Engineering Councils (SEC).

There are three aspects to the project cycle: business, budget, and technical. (K. Forsberg, H. Mooz, and H. Cotterman, 2000, p. 87-88) A template for a project cycle that one can compare to a list of events is given in the next figure. It is unwise to allow the pursuit of ‘better, cheaper, and faster’ to allow the discarding of controls and elimination of tasks without regard to the consequences. “The key to success is to design a tailored, gated cycle that is based on a proven template but that is lean, efficient, and effective.” (K. Forsberg, H. Mooz, and H. Cotterman, 2000, p. 107)

4. Types of Testing

In the acquisition cycle for the AEGIS Weapon System, many different levels of testing are performed. Based upon the past R2D2 ACB efforts, the phases of testing that have been of particular importance to the R2D2 ACB are:

1. **Land Based Computer Program Demonstration Test** – A formal test that is performed to demonstrate computer program functionality to demonstrate compliance to the top-level specification.
2. **System Program Certification Test** – Combat system certification evaluates a computer programs ability to perform required ship missions in accordance with specifications, validates computer programs do not regress from the capability of the programs being replaced, verifies the computer programs are stable in use and that the computer programs can be safely operated under normal operating conditions.
3. **Combat System Ship Qualification Trial** – A set of at-sea test and evaluation events to demonstrate weapon system functionality and the ability to perform required ship missions in accordance with specifications on a specific surface ship platform.
4. **Developmental Test (DT)** – Testing to determine technical performance and specification compliance.
5. **Operational Test (OT)** – Testing to determine the operational effectiveness of the system

Figure 4 is taken from the Program Managers Toolkit and provides a very succinct description of the Test and Evaluation phase.

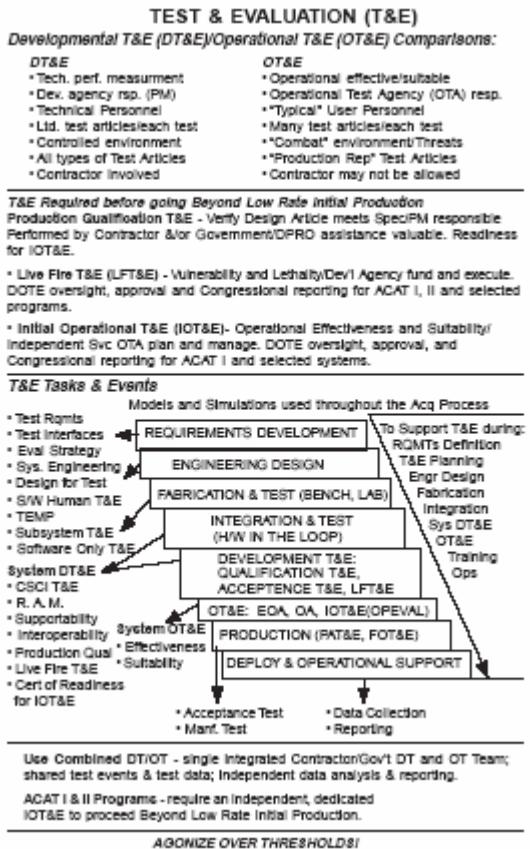


Figure 4. Test and Evaluation
(DAU Program Managers Tool Kit, 2003, p.51)

5. Risk Management and Acquisition Planning

As part of the literature review, some key points and concepts found in the Software Engineering Institute's Team Risk Management Model and the Guidelines for Successful Acquisition and Management of Software-Intensive Systems (GSAM) are provided. Risk management is a critical part of every acquisition program. An effective risk management approach will identify and plan for areas of risk in a program and analyze those risks. Once this is accomplished, a plan to monitor and control the areas of risk can be put into place. To effectively manage risk in an optimal program, trade-offs between

cost, performance and schedule will need to be performed. Risk management has been defined as “a discipline and environment of proactive decisions and actions to

1. assess continuously what can go wrong (risks).
2. determine what risks are important to deal with.
3. implement strategies to deal with those risk.”

(Higuera, R, Dorofee, A, Walker, J, Williams, R, 1994, p. 6),

At the center of effective risk management is communication. Without effective communication, the impact of an area of risk cannot be adequately assessed and dealt with. For risk management to be effective, it takes more than just the Program Manager. At all levels of the program and every phase from design to development to production, risks must be identified and mitigated where possible. When a risk cannot be effectively mitigated due to resource or other constraints, it should be documented to ensure that the program cost, schedule and performance requirements are effectively managed. (GSAM, 2000, p. 6-10) The intent is to integrate risk management into the program team efforts and not allow risks to proceed into a program undetected. As demonstrated in Figure 5, risk management requires trading off estimated cost versus potential losses.



Figure 5. Cost/Benefits of Effective Risk Management
(GSAM, 2000, p.6-6)

Risk mitigation is an important part of risk management. In this process, risk is identified and evaluated. Once this is completed, options are considered to set the identified risks at an acceptable level within the resource constraints. A critical part of this process includes assessing the possible consequences of inaction. Ignoring predictable risks is a common problem that the program manager needs to be aware of. As each risk item proceeds through the risk management process, the decision on how to deal with each risk item must be communicated to the program manager. Without authorization from the PM, resources cannot be allocated and preventative action cannot be undertaken. One risk that is true for all acquisition programs is funding. Ensuring that “a well-defined set of requirements and active management involvement” can help to mitigate this area of risk. The levels of risk are listed in Table 1.

Magnitude	Guidelines
Critical	High likelihood of severely impacting one or more factors, i.e., cost & schedule, performance, or supportability.
High	High likelihood of moderately impacting one or more factors.
Medium	Medium likelihood of moderately impacting one or more factors.
Low	Low likelihood of moderately impacting one or more factors.

Table 1. Level of Risk Management and Guidelines

(GSAM, 2000, p.6-41)

Software development programs can possess many subtle environmental risk factors (GSAM, 2000, p.6-36). Software developments can be very complex. Integration of different modules can result in complex interactions that are not easily resolved. Problem elements have multidimensional relationships. Adding more people to a project may not increase effectiveness. In fact, it may reduce the productivity of the team. Software problems can change and are inherently unstable. Actual costs and time to develop are difficult to accurately project. Software development is dynamic. Due to changes in the requirements and resources, the development progress and environment will continuously change.

Software development requires people who represent a major source of risk. Conflicts in human environment, interaction and desires will cause problems since software development is a “very human endeavor” (GSAM, 2000, p.6-36). Software development requires performing up-front, strategic planning to address problems that will be more costly to fix in the later phases. In fact,

"The time you spend defining your acquisition strategy early on will go a long way in assuring stability throughout the entire life of the system..." (GSAM, 2000, p.6-36) The use of tools such as work breakdown structures can assist in linking the strategic goals with the software development efforts. The use of open systems is expected to improve the supportability of software systems. Some classic mistakes in software acquisition include unrealistic estimates in resources required for development, inadequate software test and integration, significant code development before requirements are stable.

III. R2D2 ACB CASE STUDY

A. CASE STUDY METHODS - PAST PERFORMANCE - WHAT HAS THE R2D2 DONE?

The R2D2 ACB meetings are generally conducted using a Video Teleconference format. This medium has been selected to maximize stakeholder participation and interaction. Early on, it was determined that, due to the locations of the stakeholders, it would be difficult to get a consensus participation in one location. This ruled out the traditional announce a meeting and have everyone meet at one location, typically the Washington Navy Yard (WNY). Many of the issues that the ACB had to deal with have been complex. Discussing complex, data related issues; over a voice only teleconference was determined to be ineffective for understanding many of the issues. Email and electronic discussion boards were considered and were determined to be useful as tools, but not as the primary method of interaction.

The use of video teleconferencing has maximized participation from all stakeholders. The video teleconference format allows participation from the activity site and is the least disruptive option for stakeholder participation compared to on site meetings at WNY. For a typical meeting, there are 3 to 4 nodes. A node is a site that has a VTC connection. For example, the R2D2 ACB meeting in 29 April 2004 had 3 nodes. The nodes were at:

- NGMS, Washington DC: 80 M Street SE, Suite 500 Chesapeake Room 5123
- NSWC Corona: Building 511, Room 109A
- LM MMS, Moorestown, NJ: 4000 Building Room 374

Email communication is essential to the effective operation of the R2D2 ACB and meeting announcements are promulgated using this method. Email is frequently where issues are first socialized to determine if their importance and level of program impact merits discussion during a meeting.

Another tool that is used by the ACB is the Corporate Document Management System (CDMS). CDMS allows all documents releasable by the R2D2 ACB to be accessed by all participants. This has provided many benefits. The primary benefit is that large files such as presentations from meetings do not need to be emailed to all participants. Many participants are only interested in a subset of the issues discussed by the ACB and CDMS allows each participant to retrieve only in the information that interests them. An additional benefit is that participants' mailboxes would not be filled up with large files from the ACB meetings or information distributions. Another benefit provided by CDMS is that it provides a historical record of information on topics discussed. When a new member joins the R2D2 ACB as a participant, CDMS can be accessed to find previous information on topics of interest, allowing a new member to learn quickly about topics of interest.

The R2D2 ACB has assigned a total of 194 action items since its inception. Of these action items, only 18 action items remain open as of 15 August 2004.

B. SURVEY - FORMATS AND METHODOLOGY

Various methods were considered for a survey to gather information to answer the research questions posed in this thesis. Options for the survey included (University of Phoenix, 2002, p. 271-280):

Multiple Choice and True/False questions - Multiple choice and True or False questions were not used since they would imply a known set of answers. These types of responses are unlikely to provide insight into future directions. An objective of this research is to determine the likelihood of success for potential future opportunities and which directions are likely to be successful.

Ad Hoc questions - Ad Hoc method where questions are improvised during the survey or posed only of certain survey participants were not selected. The analysis of the data from an Ad Hoc survey is problematic as similar questions may be asked but the differences are subtle enough

to preclude having the data correlated. Ad Hoc surveys can lead to small sample sizes as most questions are unique and results cannot be easily combined.

Open-ended questions - Open-ended questions were not used for the survey. Open-ended questions do not provide a standardized set of responses that can be easily correlated.

Closed-ended questions - Closed-ended questions were used for the survey. Since the survey was distributed by electronic format and follow-up was conducted in person or by telephone, standardization of responses was a critical consideration.

Based upon discussions with the ACB Co-Chair, Geoff Uy, and ACB member Michelle Gallagher, the five questions were chosen for this survey. The questions were designed to provide insight into the success of past efforts and likelihood of success future opportunities for the R2D2 ACB. (University of Phoenix, 2002, p. 271-280):

- How effective in providing value to the AEGIS program has the R2D2 ACB been?
- How effective do you expect the R2D2 ACB to be in AEGIS Open Architecture baselines?
- How would you characterize the amount of time you are allowed to support R2D2 issues?
- At your activity, how well does the management/leadership understand and support your involvement in the R2D2 ACB?
- How much benefit do you think the R2D2 ACB concept would provide to a new weapon system program?

The following choices for possible answers to each question were provided as follows:

1. Excellent or Extremely Effective
2. Good or Very Effective
3. Fair or Effective
4. Poor or Ineffective
5. No Opinion

The selection of these choices will allow for a quantitative and qualitative analysis. (University of Phoenix, 2002, p. 271-280)

C. OPEN ARCHITECTURE

Open architecture is a concept that is being put into practice that allows for information to flow across boundaries and allow for interoperability between systems or components. The OPEN Group defines the characteristics of information flow across system boundaries as:

"It has open standard components that provide services in a customer's extended enterprise that: Combine multiple sources of information, Deliver information to the places where that information is needed, and In the right context for the people or systems using that information. "(Blevins, T., 2004, ¶24)

Designing open systems is a challenge not only to the commercial industry but for military systems as well. The Open Systems Joint Task Force has defined Open Systems as "A System That Implements Sufficient Open Specifications for Interfaces, Services, and Supporting Formats to Enable Properly Engineered Components to be Utilized Across a Wide Range of Systems With Minimal Changes, to Interoperate With Other Components on Local and Remote Systems, and to Interact With Users in a Style That Facilitates Portability." (Strei,2003, p. 6) The R2D2 ACB is chartered to ensure that the information that is collected for combat weapon systems such as the AEGIS platform allows for a reconstruction of events involving the weapon system. The reconstruction of events is not limited to test and evaluation but extends to events occurring during ship operations including ship deployments and the data recording and extraction capability to support the performance assessment of the combat weapon system.

There are two parts to the OA Transformation:

1. The OA Transformation Roadmap is designed to quickly rollout Navy Open Architecture (NOA).

2. The Rapid Capability Insertion Process/Advanced Processor Build (RCIP/APB) to facilitate the insertion new capability within the Open Architectures as they are developed and become available.

(Rushton, W. CAPT, USN et al, 2004, p. v)

There are a number of platforms that are programmed for Open Architecture including the DD(X) Multi-Mission Destroyer and the CG/DDG AEGIS platforms as shown in Figure 6. With a large number of platforms converging to open architecture, the data recording and reduction requirements from one platform is likely to impact other platforms as these open systems are integrated together to meet the objectives of Network Centric Warfare through the implementation of FORCENET. While the introduction of COTS hardware has been implemented in some cases, OA will bring commercial software structures and designs into combat weapon systems to support the COTS hardware and complete the replacement of obsolescent MIL-STD systems.

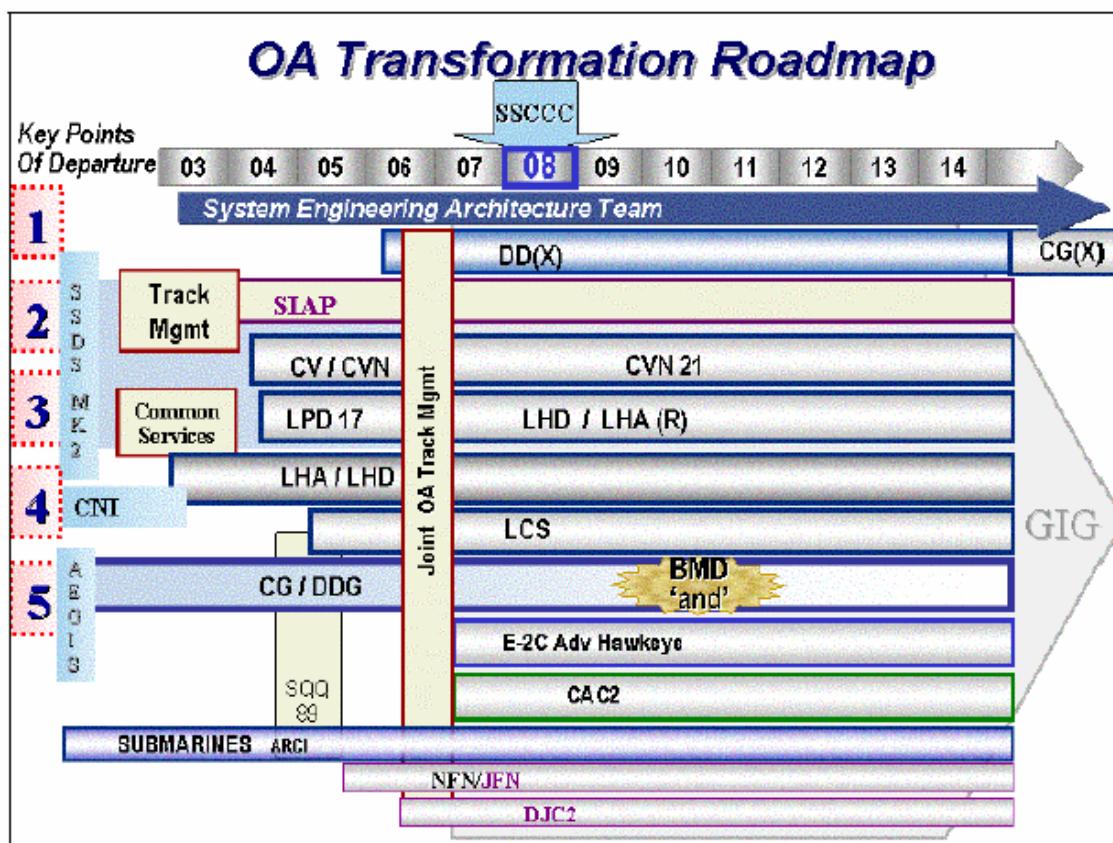


Figure 6. OA Transformation Roadmap

(Rushton, W. CAPT, USN et al, 2004, p. 29)

The two programs that are specifically being researched in this study are:

- AEGIS Open Architecture (AOA)
- DD(X)

Both of these platforms are Naval Surface Combatants that have been required to implement architecture that is compliant with Navy Open Architecture (NOA) standards.

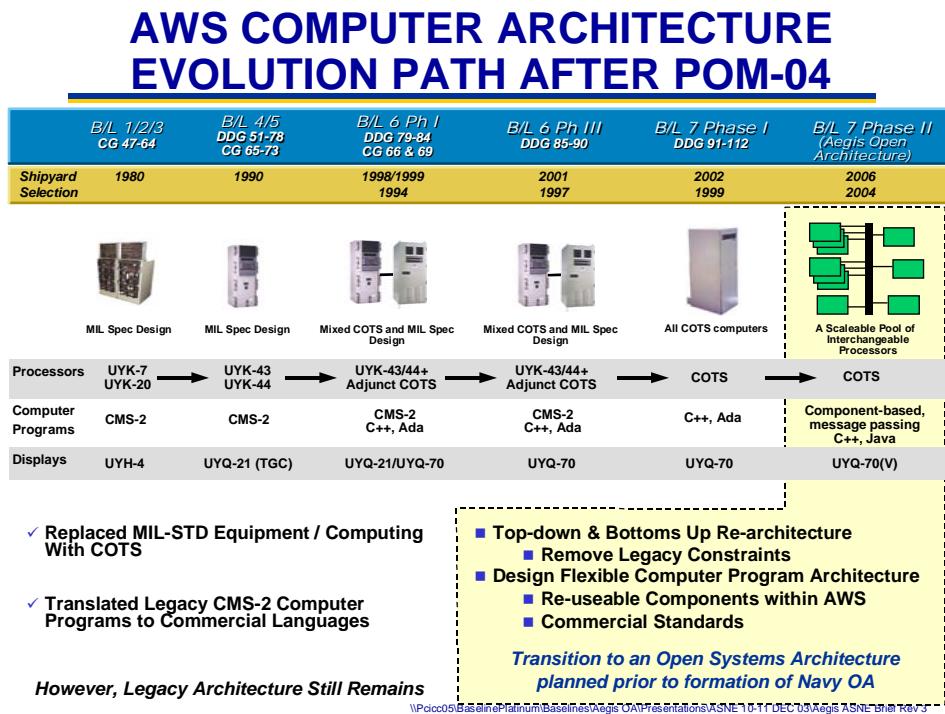


Figure 7. AEGIS Baseline Architecture

(Williams, J., 2003, p. 4)

The development of AWS has been incremental and evolutionary over time. As shown in Figure 7, early AEGIS baselines were MIL-STD equipment and COTS introduction began with Baseline 6 Phase 1. A demonstration test of the first all COTS AEGIS Baseline, 7 Phase 1 was completed in August 2003. AEGIS Baseline 7 Phase 1C, the first AEGIS baseline to implement AEGIS Open Architecture, is scheduled for demonstration testing in 2005. AEGIS Baseline 7

Phase 1C is accomplishing this through the use of evolutionary and spiral development. There are 3 spirals planned for AEGIS Baseline 7 Phase 1C. AOA is being implemented in 5 spirals as shown in Figure 8. The implementation of this architecture is spread across three areas that are: Radar Control, Weapons Control, and Display.

Incremental Fielding of Capabilities



	Spiral 1	Spiral 2	Spiral 3	Spiral 4	Spiral 5
Radar Control	<ul style="list-style-type: none"> • Core AAW for SPY-1B • Prelim OACE Integration • Redundant Recovery 	<ul style="list-style-type: none"> • SPY-OA for SPY-1B/D(V) • Prelim DRM Recovery • Final OACE Integration 	<ul style="list-style-type: none"> • Final DRM Recovery • Burnthru Re-allocation • Complete Radar Scheduler 	• ERAM Integration	• Missile Defense Integration
	<i>FY06/FY07 CG Conversion</i>	<i>DDG 103 AF</i>	<i>FY08/FY09 CG Conversion</i>	<i>FY10 CG Conversion</i>	<i>FY11CG Conversion</i>
Weapons Control	<ul style="list-style-type: none"> • Core AAW SM MR • Prelim OACE Integration 	<ul style="list-style-type: none"> • Air Control • CEC Engagements • ESSM • Final OACE Integration 	<ul style="list-style-type: none"> • CIWS • SM ER • Guns • Final DRM Recovery 	• ERAM Integration	• Missile Defense Integration
			<i>FY08/FY09 CG Conversion</i>	<i>FY10 CG Conversion</i>	<i>FY11CG Conversion</i>
Display	<ul style="list-style-type: none"> • Partial CDK Replacement • Enhanced TACSI • Prelim OACE Integration 	<ul style="list-style-type: none"> • HSI Enhancements: <ul style="list-style-type: none"> • Improved GUIs • Alert Re-design • Final OACE Integration 	<ul style="list-style-type: none"> • Full CDK Removal • DRM Integration 	<ul style="list-style-type: none"> • ERAM Integration • Further HSI Enhancements 	• Missile Defense Integration
		<i>DDG 103 AF</i>	<i>FY08/FY09 CG Conversion</i>	<i>FY10 CG Conversion</i>	<i>FY11CG Conversion</i>

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4

Figure 8. AEGIS Open Architecture Spirals
 (System Engineering Management Plan (SEMP) For AEGIS CG/DDG
 Open Architecture (Draft), 2003, p. 11)

Through the use of evolutionary and spiral development, AEGIS will be able to build a little and then test the result. This strategy will be critical to the ultimate success of AOA since the adaptation of the system is occurring in spirals. The spiral development process presents challenges in the data dictionary, recording and reduction arena as well. As functionality is migrated to open architecture, the challenge is to ensure that the information required to evaluate the system is adequate and available.

D. DD(X) NEXT GENERATION DESTROYER

The DD(X) multi-mission destroyer program is being developed to meet the NOA standards. The DD(X) platform is attempting to pursue advanced Open Architecture concepts including the Total Ship Computing Environment (TSCE) and modular design. As NOA has a Network Centric Warfare (NCW) implementation, the validation of data as it travels from one element to another element will be a critical component of the success of this weapon system. Figure 10 shows the transformational components in the DD(X) multi-mission destroyer which is designed for littoral and network centric warfare.



Figure 9. DD(X) Multi-Mission Destroyer

(DD(X) Multi-Mission Destroyer, 2004)

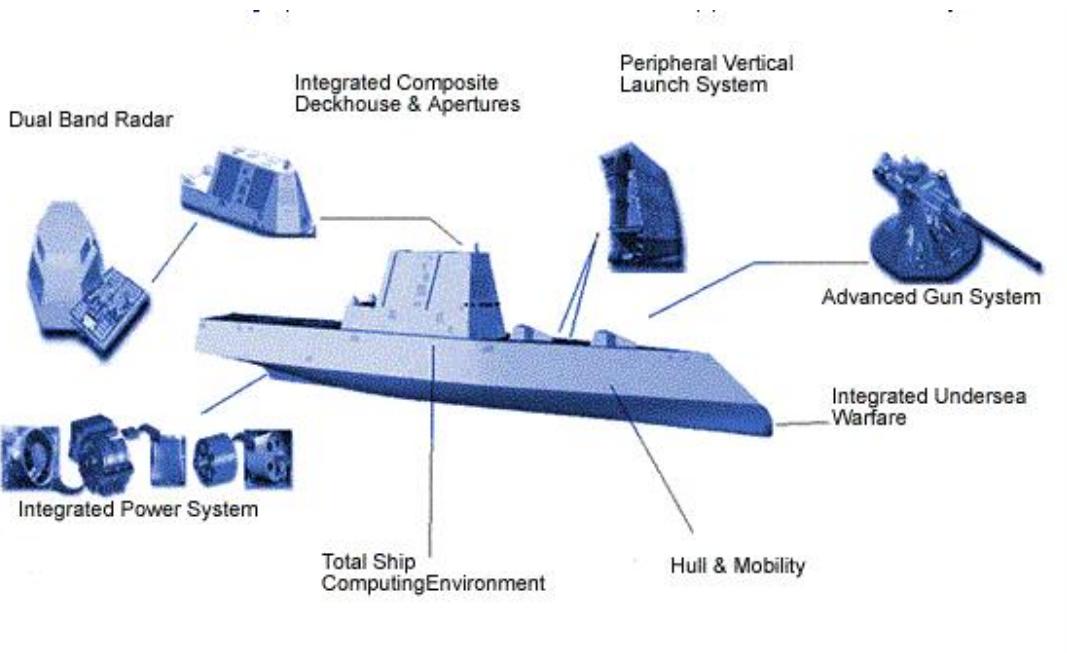


Figure 10. Breakout of the DD(X) Transformational Systems.

(DD(X) Transformational Systems, 2004)

The initial design includes the following transformational systems (DD(X) Transformational Systems, 2004, ¶1) that may require data recording and reduction:

- Total Ship Computing System – The Local Area Network responsible for integrating warfare capability within the weapon system platform. TSCE will provide a Common Operating Picture (COP) by fusing together data provided by the onboard sensors and systems and data received from external sources. TSCE is designed to the requirements of NOA.
- Advanced Gun System – Designed to provide greater firepower while being unmanned. Provides a land strike capability through the ability to fire advanced munitions and propelling charges. A GPS guided Long Range Land Attack Projectile (LRLAP) is one of the expected projectiles to be developed for this system.
- Integrated Undersea Warfare – Designed to provide In-stride Mine Avoidance using a dual (HF/MF) frequency bow array

- Peripheral Vertical Launch System – Designed to launch STANDARD SM-2 and Evolved Sea Sparrow Missiles that are placed in a modularly designed launcher. By placing the launchers along the perimeter of the ship, reduces the loss of cells from a single hit.
- Dual Band Radar – Integrates two active phased-array radars for detection of potential threats and fire control illumination during the engagement of selected threats. DBR will integrate the L-Band Volume Search Radar with the X-Band Multifunction Radar to perform search and track performance.

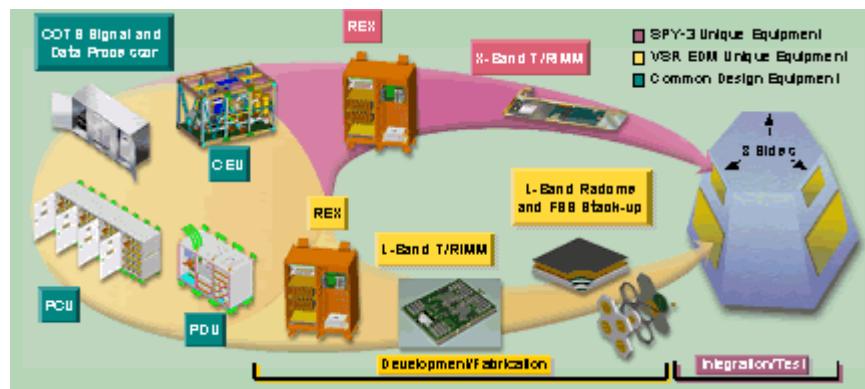


Figure 11. Components of the Dual Band Radar.

(Dual Band Radar, 2004)

As the design of combat weapon systems such as the DD(X) becomes more automated in the pursuit of reduced manning levels, more information will need to be captured to ensure that system responses to internal and external stimuli can be reconstructed. As the first built-from-scratch open architecture combat weapon system, the data recording philosophy and structure will be carried into many future combat weapon systems as modules from this platform are reused in future systems. The development of the DD(X) platform as a network centric platform will provide opportunity to use open architecture components for other platforms on the OA Transformation Roadmap (Figure 6). Assuming a complete level of conformance to open architecture requirements, functional modules from one weapon system could be easily moved to another system. (Rushton, W. CAPT, USN et al, 2004, p. 29-32)

E. TRENDS IN DEFENSE

As Secretary of Defense, The Honorable Donald Rumsfeld, stated on 4 June 2004, “If the Department of Defense is to stay prepared for the security challenges of the 21st century, we must transform not just our defense strategies, not just our military capabilities, not just the way we deter and defend—but we must also transform the way we conduct our business.” (Glaros, 2003, p. 1) The R2D2 ACB must consider how this transformation will affect Test and Evaluation Events and areas within the R2D2 ACB charter. Since the R2D2 ACB has been responsible for Naval Weapons Systems, the Navy’s vision outlined in SEA POWER 21 will be the guiding document for determining trends in defense that the R2D2 ACB should align to.



Figure 12. SEA POWER 21

(Clark, 2002, p. 1)

In SEA POWER 21, the ability to share information is discussed. SEA POWER 21 states “Once information is acquired, it must be shared and processed to achieve knowledge dominance, leading to operational advantage. To meet this challenge, the Navy has been improving data sharing among

platforms, including Link 16, the Cooperative Engagement Capability..."(Mayo & Nathman, 2003, p. 2). Link 16 and Cooperative Engagement Capability (CEC) are an integral part of the AWS and will be part of DD(X). As information is shared across many platforms, the data will become part of the system. NCW will allow the integration of the battlegroup to respond to threats more quickly. SEA POWER 21 "will require new models for command, control, and data flow." (Mayo & Nathman, 2003, p. 1) resulting in the need to integrate data from many platforms to understand system performance. SEA POWER 21 will provide the warfighter with a complex set of data on which to base responses to possible threats. In this changing environment, "rapid information collection, analysis, dissemination, decision making, and execution are critical to winning the life-and-death race for combat effectiveness. Swift and effective use of information will be central to the success of SEA POWER 21." (Mayo & Nathman, 2003, p. 1)

Part of SEA POWER 21 discusses the concept of Sea Basing that allows the Navy to be on the scene and in theater wherever needed. To meet this objective, the Navy is relying on new systems that are being designed to open architecture standards. These systems include the CVN(X) nuclear-powered aircraft carrier and the multi-mission DD(X) destroyer. The CVN(X) and DD(X) platforms will have significantly lower manning levels than previous generation aircraft carriers and destroyers. To reduce manning levels, more autonomy of the systems on the ship will be required, including the combat system. As there is less man-in-the-loop, validity of data in the system will become more critical to ensuring the quick and appropriate response to imminent threats. As advanced weapons and sensors are netted together, the requirements for data processing and transfer will continue to grow exponentially.

Vice Admiral Albert Konetzni, the Deputy Commander and Chief of Staff for the Atlantic Fleet discussed the need for "solid intellectual analysis" (Costa, 2003, p. 19) while transforming our defense capability. He discussed the lack of rigor in operation analysis in favor of stop light charts in PowerPoint presentations without substantive analysis to support it. (Costa, 2003, p. 19) The R2D2 ACB has provided a forum for supporting rigorous analysis of test events.

The R2D2 ACB has worked to ensure that the data required for analysis of the AEGIS weapon system is designed into the system. VADM Konetzni recommends “using realistic scenarios and experiments to make sure they will work as advertised”. (Costa, 2003, p. 20) By ensuring that the data required for analyzing these tests, the R2D2 ACB is working toward this goal.

The importance of incorporating modeling and simulation to reduce the reliance on live fire testing is discussed in the Chief of Naval Operations (CNO) Guidance for 2004, Accelerating Our Advantages. The use of modeling is consistent with the reduction in live fire events that has been evident in the AEGIS program in recent years. The use of modeling is consistent with the Sea Enterprise initiative to “leverage technology to improve performance”. (CNO Guidance for 2004, Accelerating Our Advantages, 2003, p. 20) The AEGIS program has a history of using land based testing and simulated testing on the ship platform. The resolution of track identification in a joint environment will continue to present problems in assessing combat weapon system performance. The reduction of live fire test and evaluation events will require the collection and analysis of data from modeling and simulation combined with data from events at test ranges, land based test sites and, all other available test facilities in order to effectively evaluate system performance.

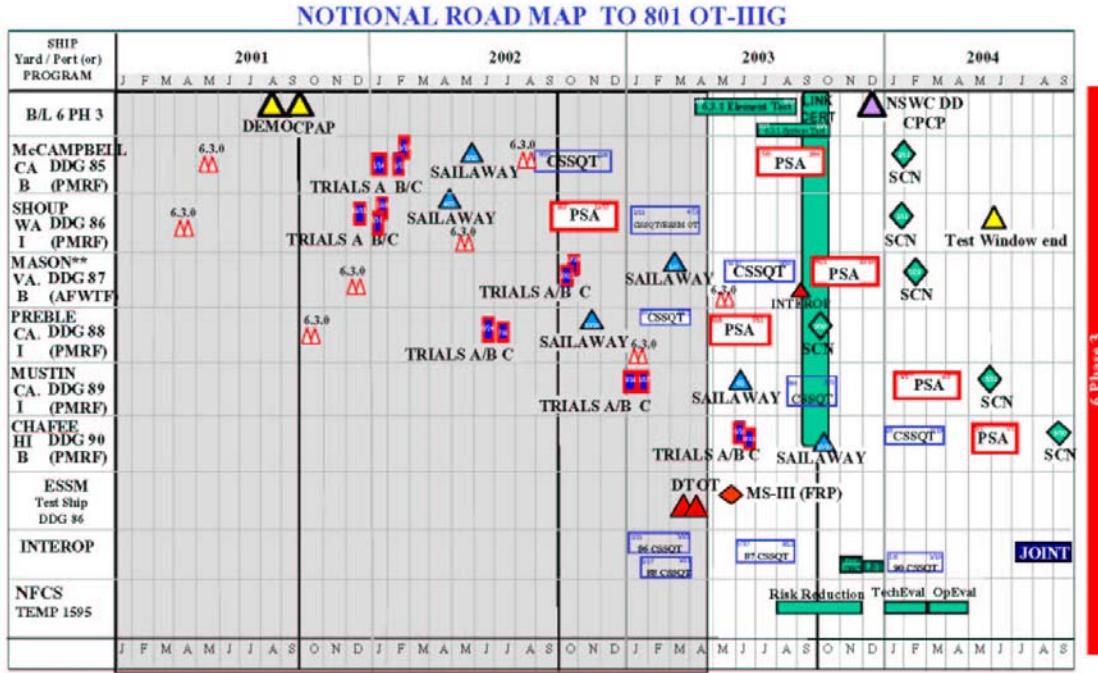
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IV. RESEARCH ANALYSIS AND APPLICATION

A. INTRODUCTION

The design of the R2D2 ACB is intended to be similar to an Integrated Product Team that is limited to the areas affected by data recording. The ACB has a cross section of system designers and users. In this case, the users are the analysts who require data to perform their function. While IPT's have authority to make decisions within the scope of their effort, the R2D2 ACB collects information and informs the program manager on data dictionary, recording and reduction issues. The ACB does not have the authority to implement a decision. The R2D2 ACB, unlike some IPT's, does not choose its membership. Each activity assigns the people that they desire to support this effort and can remove or change members based upon changing priorities within the activity. This has resulted in the loss of some of the most productive members of the ACB; however, membership changes have provided the opportunity to find new champions for the R2D2 ACB within their respective organizations.

The involvement of the R2D2 ACB has changed as recent AEGIS baselines have been introduced. In AEGIS Baseline 6 Phase 1, the R2D2 ACB did not exist until late in the design and development cycle. Accordingly, the ACB was able to assess past mistakes and try to determine lessons learned for future baseline development. The roadmap for AEGIS Baseline 6 Phase 3 developments that were presented in the CNO Project 801 (DDG 51 Class) CNO Project 1669 (Cruiser Modernization) R2D2 In-Brief is illustrated in Figure 13.



Dates for the Trials, PSA and SCN Cutoff are based on the 1 April 2003 DDG 51 Class BIW MYP Schedule.
CSSQT Dates are based on 1 May 2003 Test and Evaluation (T&E) schedule. All other dates
are based on other source data.

** Test Ship

<https://aegistechdiv.navsea.navy.mil>

UPDATED: 1 May 2003

Figure 13. Baseline 6 Phase 3 Development

(Howard, 2004, p. 5)

The R2D2 ACB was being established as the 6 Phase 3 Baseline was completing design and preparing to multi-element integration and test (MEIT). Baseline 6 Phase 3 provided an opportunity for the R2D2 ACB to effect system modification decisions through the Test Observation Report (TOR) mechanism. The TOR process provides a method for collection and prioritization of system performance anomalies detected during MEIT, engineering test and evaluation, system and demonstration testing of the computer program baseline. TORs are rated on a 1 to 5 scale based upon the risk to the program. The scale is as follows (AEGIS Performance Report for CEC OPEVAL, 2001):

Priority	Description
1	Mission Failure or Safety problem
2	Mission Degradation
3	1 or 2 with an acceptable workaround. No workarounds allowed or safety problems
4	Operator annoyance or nuisance
5	Not visible to the operator or no tactical impact (doc change). Visible but trivial problem, e.g. misspelling on a CRO

Table 2. TOR Priorities
 (AEGIS Performance Report for CEC OPEVAL, 2001)

Data recording issues were traditionally downgraded to priority 4 or 5 since a ‘work around’ could be provided. This was appropriate in many cases. However, some data recording issues were found to affect the assessment of system performance during CSSQT and DT/OT testing. The ‘work around’ that was acceptable in a lab test environment was not available during the formal at-sea testing. In the lab, a test for a specific function could be conducted repeatedly, but in at-sea testing, the testing is very limited due to the high expenses of ranges, targets, ordnance, and test teams. A TOR Form is included in Appendix C.

An example of a low priority observation occurred during an AEGIS CSSQT test event. A target was presented to an AEGIS destroyer for engagement to determine the effectiveness of the combat weapon system. When the target was ready to be engaged, the AEGIS Display System (ADS) displayed incorrect information to the console operator resulting in the operator choosing not to engage the target. The system displayed information from when the console had been in test mode rather than the present state of tactical mode. While the state of the console being in test mode or tactical mode was considered an operator annoyance (Priority 4) in the lab, the impact was much different during actual at-sea testing.

AEGIS Baseline 7 Phase 1 provides the completion of the re-architecting of the AWS to COTS technology. The R2D2 ACB was established and able to influence the program development at an earlier stage than in Baseline 6. At the time of this writing, AEGIS Baseline 7 Phase 1 was preparing for its first CSSQT

testing with the USS PINCKNEY (DDG 91). A notional illustration of the scheduled testing is provided in Figure 14 as presented in the CNO Project 801 (DDG 51 Class) CNO Project 1669 (Cruiser Modernization) R2D2 In-Brief. As a result of earlier involvement, a significant effort was undertaken to document extraction points and capture information that had been lost in the data dictionaries as a result of the introduction of COTS. While the results did not provide everything that the analysis community desired, significant progress was made. Early progress is critical for another reason. In the AEGIS baseline development, a capture of the previous baseline was performed for the starting point of the next baseline. Changes that are made to the computer program after baseline capture must be reinserted if it is to be included in future baselines. This has proven to be an expensive and difficult path to pursue.

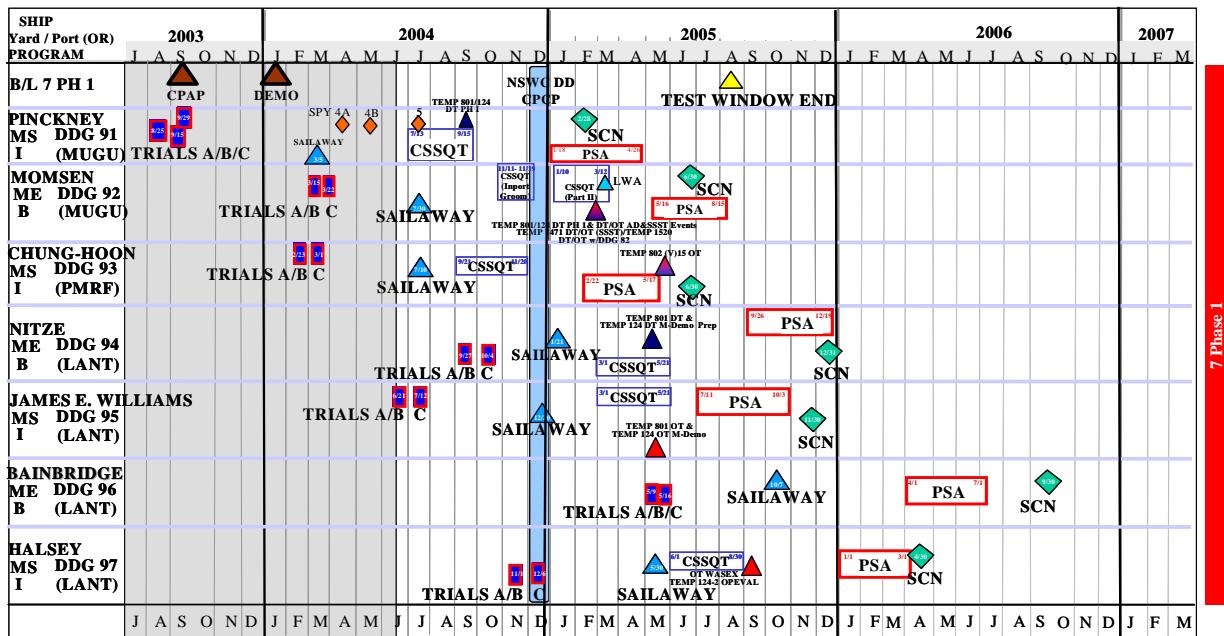


Figure 14. AEGIS Baseline 7 Phase 1 Development
(Howard, 2004, p. 7)

AEGIS Baseline 6 Phase 3 provides an excellent example of why early involvement is critical to getting an essential data recording capability into the baseline. The ADS displays tracks to the operator that are provided by the C&D computer via the ADS Track Server. During AEGIS testing, it was noted that some tracks did not appear at the console as expected. Review of the data

recording capability showed that the tracks could be found in the C&D Track Database file but there was no data to indicate when a track was actually displayed to the operator at an ADS console. The inability to determine whether a track was present at a console from the test data was determined to be an operational issue. Initially, the R2D2 ACB was unable to convince the system developer or program manager to implement a change in the Baseline 6 Phase 3 computer program to collect and record this information. After a number of tests indicated the value of this information, the Program Manager became convinced of the importance of this data. The system developer was instructed to determine a method to collect this information and the associated cost. After an agreement was reached, the ADS Track File Data Recording (TFDR) was scheduled into the development path. Unfortunately, this change was not captured in Baseline 7 Phase 1. It remained an open issue as to whether the program manager for this baseline will capture this functionality. However, even if this functionality is eventually captured into Baseline 7 Phase 1, it was too late for it to be captured directly into Baseline 7 Phase 1C and will likely be too late for Baseline 7 Phase 1R.

As the development of Baseline 7 Phase 1C begins, the R2D2 ACB is attempting to be inserted earlier than in the Baseline 7 Phase 1 process. Figure 15 illustrates the programmed development schedule for this baseline, which was presented in the CNO Project 801 (DDG 51 Class) CNO Project 1669 (Cruiser Modernization) R2D2 In-Brief. Baseline 7 Phase 1C is the first AEGIS Open Architecture Baseline and the ability for the R2D2 ACB to affect the development of the data recording remains to be seen.

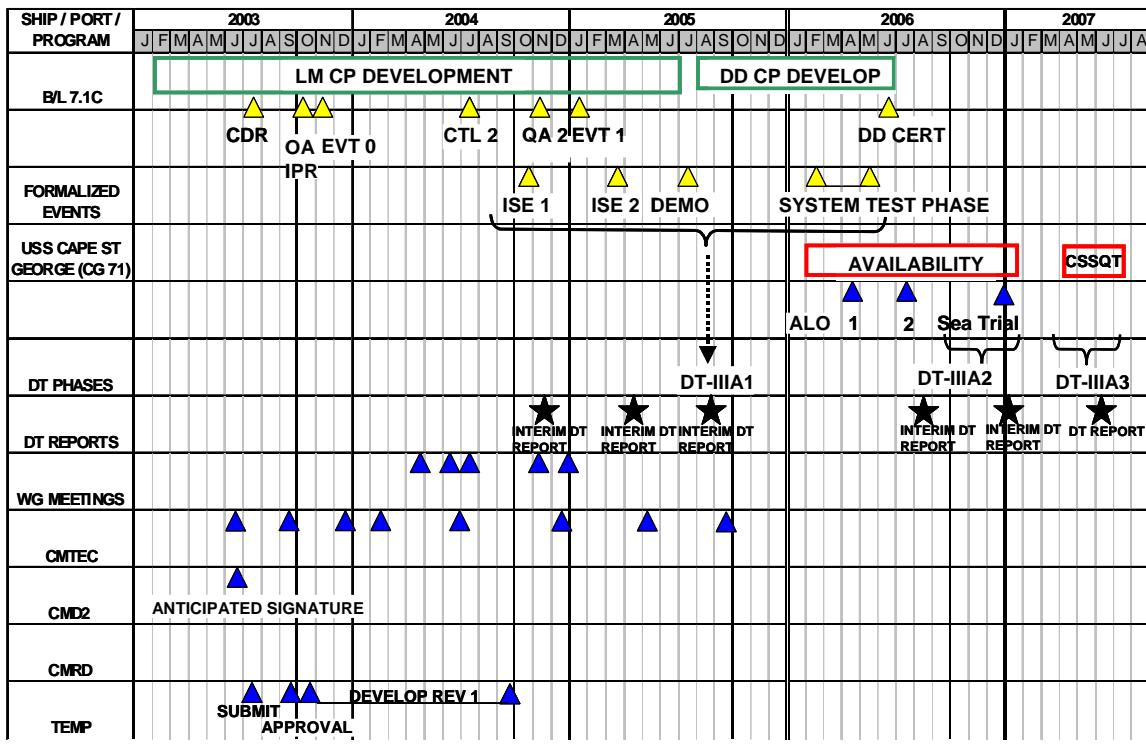


Figure 15. Baseline 7 Phase 1C Development
(Howard, 2004, p. 15)

B. SUMMARY OF INTERVIEWS AND SURVEYS

A survey was distributed to determine the effectiveness of the R2D2 ACB from the perspective of the core participants. The selection criterion was people who regularly attend and participate in the ACB. A total of eighteen people met the attendance and participation criteria and were surveyed. While there have been more participants in the history of the R2D2 ACB, the survey population represents the active core that has allowed the R2D2 ACB to perform its mission. Based upon discussions with Mr. Uy, R2D2 ACB Co-Chairman, the survey population was selected based upon the following criteria: number of meetings attended, knowledge of data dictionaries and data reduction, area of technical expertise and level of participation in meetings. The survey results are listed in Table 3.

	Excellent or Extremely Effective	Good or Very Effective	Fair or Effective	Poor or Ineffective	No Opinion
How effective in providing value to the AEGIS program has the R2D2 ACB been?	33.3%	55.6%	11.1%	0.0%	0.0%
How effective do you expect the R2D2 ACB to be in AEGIS Open Architecture baselines?	22.2%	55.6%	22.2%	0.0%	0.0%
How would you characterize the amount of time you are allowed to support R2D2 issues?	11.1%	33.3%	44.4%	11.1%	0.0%
At your activity, how well does the management/leadership understand and support your involvement in the R2D2 ACB?	55.6%	0.0%	44.4%	0.0%	0.0%
How much benefit do you think the R2D2 ACB concept would provide to a new weapon system program?	77.8%	11.1%	11.1%	0.0%	0.0%

Table 3. Survey Results

Each question will be addressed along with an analysis of the results and discussion of survey comments provided by respondents that are relevant to that question. One result that applied to the survey as a whole was that no answers of ‘No Opinion’ were received. As the criteria included participation, the level of involvement required to receive the survey provided a survey pool that had generally produced strong opinions on each of the subject areas addressed by the survey questions. Since the survey population consisted of active participants in the R2D2 ACB, this result was expected.

1. Survey Question: How effective in providing value to the AEGIS program has the R2D2 ACB been?

The first question intended to capture the perceived value that the R2D2 ACB has provided. Most respondents (89%) believe that the R2D2 ACB has been very or extremely effective. This result is validated by the fact that the R2D2 ACB continues to exist. If the participants did not believe that the R2D2 ACB was effective, they would elect to not participate and find other activities to engage in. Some program managers and system developers do not view data

recording as a critical component of the system under development. The experience of the R2D2 ACB has shown that data recording problems have been downgraded in favor of more visible tactical system software issues. (Johnson, 2001) The R2D2 ACB is a champion of the importance of data recording to understand what needs to be fixed. By designing a robust data recording capability, system problems can be isolated more rapidly with less testing and solutions can be quickly verified. The introduction of COTS has allowed methods for debugging computer program development through methods other than data recording. Prior to COTS, the program developers depended upon the ATES data recording to obtain memory dumps that were used to determine program faults and errors. On the positive side, the opportunity to bring together the program developers, program managers and analysis community was viewed as beneficial in reducing redundant efforts and allowing the validation of problems and their importance. The R2D2 ACB provided the ability for open dialog in discussing the issues, mitigation, and planning implementation. With the diverse AEGIS community, the ACB allows understanding of the impact a change might have to another organization in near real time. As long as the AEGIS program continues to change, there will be a need to test it and work though issues that will arise - that is where the strength of the R2D2 ACB exists.

2. Survey Question: How effective do you expect the R2D2 ACB to be in AEGIS Open Architecture baselines?

The second question is a forward-looking question to provide insight into the R2D2 ACB participant's opinion of the future for the ACB. All future development for the AEGIS program is programmed for the AEGIS Open Architecture baselines once development of Baseline 7 Phase 1 is completed. In the opinion of 78% of the survey respondents, Program Manager buy-in is viewed as critical to the success in future baseline development. In the AEGIS OA development, the use of Technical Performance Measures (TPM) has been contractually employed. The use of TPM's can be used to require data recording to be satisfied providing a motivation to the developer to ensure that specific data

recording capabilities are designed into the system. The R2D2 ACB could provide the Program Manager with the most critical areas to be measured and the requirements for a robust data recording capability. The R2D2 ACB would enable the data analysis community to become proactive in deciding what needs to be measured as the baseline is tested. Without a proactive approach, the data recording is likely to be an early casualty of budget and resource allocations and, as has happened in previous baselines, data recording will always be playing catch-up. Finally, the R2D2 ACB is in a unique position to see the data problems (both engineering and political) facing such a transition.

3. Survey Question: How would you characterize the amount of time you are allowed to support R2D2 issues?

The third question is intended to provide the participant's perspective on how much effort they are able to provide toward the R2D2 ACB efforts. The survey results indicated that over 50% of the respondents characterize their ability to support the R2D2 ACB as fair or poor. Based upon discussions during previous R2D2 ACB meetings, two issues that have limited the ability of ACB members to support this effort are funding and collateral duties. The R2D2 ACB efforts are not separately identified in the funding documents. While the program office expects each activity to use baseline development funding for this effort, there is no specific funding allocated directly for this effort. When a conflict in responsibilities occurs, the bias is toward the tasks that are directly referenced in funding documents or statements of work. Other times, collateral duties can overwhelm the work schedule and result in R2D2 ACB efforts being minimized.

4. Survey Question: At your activity, how well does the management/leadership understand and support your involvement in the R2D2 ACB?

The fourth question is designed to correlate the previous question. In cases where an insufficient time is allowed, to what degree does this contribute

to management being unaware of the R2D2 ACB's mission and benefits? For those who are satisfied with the amount of time available for R2D2 efforts, does it result in management support? Even in cases where the management understands the importance of participation in the R2D2 ACB, priorities can overtake R2D2 efforts when direct work traceable to tasking is at stake. Another problem is that some people receive good support while co-workers receive somewhat less support due to different managers perception of the R2D2 ACB.

5. Survey Question: How much benefit do you think the R2D2 ACB concept would provide to a new weapon system program?

The final question is designed to determine if the respondent believes that the R2D2 ACB is unique to AEGIS or if it can grow beyond this program. The critical concern is that the program managers understand and champion this effort. Every mission is going to require a data recording capability to measure its results. This is not unique to the Navy or DOD. NASA relies on telemetry data to determine if its space probes are operating correctly and commercial aircraft contain "black boxes" that contain data recording deemed critical to reconstruct aircraft and aircrew performance. A significant benefit that the R2D2 ACB can provide is combining lessons learned and guidance on data recording, extraction, processing and analysis techniques and methods to programs in the process of defining and developing these capabilities.

The survey results indicate that 78% of the respondents reported that the R2D2 ACB efforts would be extremely effective for a new weapons program. Since the ACB has been established for over 3 years, the positive views presented in the survey results are not the result of unguarded optimism for a new effort. Rather, it represents a time-tested reflection upon the accomplishments of this forum. By providing a forum where issues and deficiencies can be discussed without attribution, many R2D2 ACB members have been able to raise issues for investigation that would be difficult to carry forward at their activity. The R2D2 ACB can take action and allow the

membership to investigate issues as an ACB action rather than an individual concern. Furthermore, the management at an activity recognizes that action items assigned through the R2D2 ACB have been through a peer review process to determine that the issue is valid and important to the AEGIS program.

C. R2D2 ACB AND RISK MANAGEMENT

Based upon the experience of the R2D2 ACB to date, the primary functions that it performs are to review and monitor data dictionary and recording issues as the analysis community identifies the issues. The R2D2 ACB effectively performs risk analysis for the Program Manager. Each issue is identified and analyzed. Part of this process includes determining the impact on the program performance and schedule. As the R2D2 ACB evaluates issues, consideration is given to assess what information is lost resulting from each specific data dictionary and recording issue. Next, the risk resulting from each issue is documented through ACB meeting discussions and action item assignments. Once the issue is defined and understood, the analysis community provides feedback to determine how the problem may be addressed. Once an issue is defined and a solution identified, the Program Manager is provided the information necessary to determine whether the resources required that would resolve the problem is worth the tradeoff of resources for other uses.

The R2D2 ACB provides consistency in prioritizing and investigation of data dictionary and data recording issues. Past experience in the AEGIS program has demonstrated a dependency upon the Program Manager. When a Program Manager is concerned about data dictionary and data recording issues, a significant effort is expended to resolve these issues. If a program manager's decisions demonstrate that data recording is a low priority, other issues will absorb resources needed for fundamental data recording capability. However, if the R2D2 ACB is institutionalized, as it has been in the AEGIS program, the program manager has the technical resources readily identified and a chairman to describe the status of the data recording capabilities in the AEGIS baseline

development. Additionally, the institutionalization of the R2D2 ACB has served to educate members of the program office beyond the program manager, and develop the expectation that a fundamental data recording capability is an essential part of the AEGIS baseline development process because the value added has been shown in previous AEGIS baselines. Finally, the R2D2 ACB provides the program manager a motivated group of technical experts ready to help resolve problems as they are discovered. Through the use of technologies such as video teleconferencing, the R2D2 ACB has remained flexible and responsive in support of emergent data recording issues requiring investigation.

D. APPLICATION OF STUDY

1. Open Architecture

The AEGIS program has been in the process of adopting COTS technology as quickly as possible without assuming too much risk in the program. Beginning in Baseline 6 Phase 1 and continuing into Baseline 7 Phase 1, COTS technology has been inserted. Baseline 7 Phase 1 is the first AEGIS Baseline to have all COTS hardware for the AWS. The baseline development succeeding Baseline 7 Phase 1 are designed to be AEGIS Open Architecture baselines with the intent of capturing the complete benefit of COTS.

The challenge facing the R2D2 ACB is how to respond to the changes presented by open systems. The introduction of COTS in Baseline 6 Phase 1 required the development of the DXR data-recording format. The DXR format lacks features possessed by the ATES format that are useful to combat weapon system analysts due to the significant differences between the ATES and DXR formats. Each Spiral represents a new opportunity to provide technical support to the AWS baseline design and development team. Information on how to improve the data dictionaries and data recording from the previous Spiral can be provided. The R2D2 ACB will provide a resource to the design and development team as well for assessing the impact of changes to the AWS computer program

as they are considered rather than implementing and requiring rework to restore lost and required capabilities.

The issues that the R2D2 ACB must resolve are critical to the successful evaluation of the combat weapon system performance and require a high degree of collaboration throughout the entire AWS analysis community. In order for the decisions of the R2D2 ACB to be respected and conformed to, the Program Manager must provide a clear and unambiguous level of support. For AEGIS Open Architecture, the real challenge is to continue to add value to the AEGIS program as it is converted into an open system.

2. DD(X) Next Generation Destroyer

The DD(X) platform is being designed to open architecture standards. As a new program, most of the people involved in the DD(X) program are unaware of the R2D2 ACB. The first step toward application of the R2D2 concept is information and education. The program managers in the DD(X) program are unable to implement a structure similar to the R2D2 ACB if they are not aware of its benefits. Additionally, the program managers need to be introduced to the people who can provide the expertise to initiate this type of ACB. Once the program managers decide to implement a R2D2 ACB, the system designers need to be introduced to the concept of the R2D2 ACB and the systems engineers who will be analyzing the performance of the combat weapon system need to be identified. With the program managers, system designers and analysts identified, the R2D2 ACB can start exchanging information. Traditionally, the R2D2 ACB has used the VTC format along with an electronic document management system. The choice of mediums used for information exchanges can be tailored to those that will be the most effective for the participants. Direct meetings can be more effective if all of the participants are closely located and email can facilitate a very large distribution list of participants.

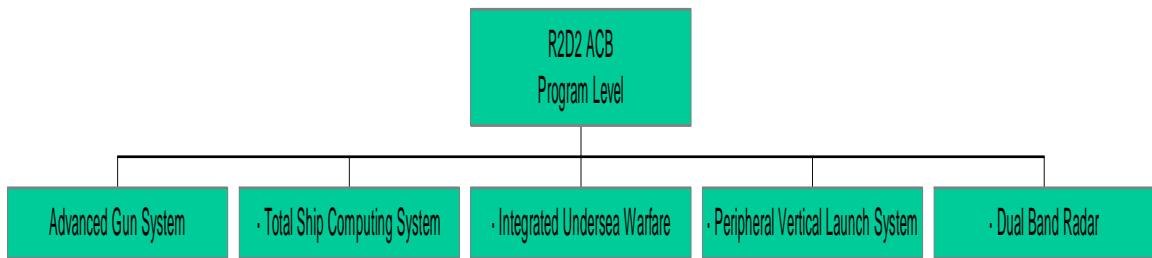


Figure 16. DD(X) R2D2 ACB Structure

With the development of a number of new systems, a possible application of the R2D2 ACB is tailored approach of semi-autonomous groups that are assigned to each element or group of elements. A possible structure for this approach is shown in Figure 16. By using functional working groups, the program managers could direct resources to the area or areas with the most critical problems that should reduce the overall risk in the area of data dictionaries and data recording. As the program progresses through its development cycle, the R2D2 ACB will be in place to support the formal Test and Evaluation events such as Developmental and Operational Testing that have relied heavily on recorded test data for system evaluation.

V. CONCLUSIONS

A. INTRODUCTION

The R2D2 ACB has been an effective tool available to AEGIS program managers since its inception in July 2001. Initially, the focus of the R2D2 ACB was on issues related to the ADS element of the AWS. As the R2D2 ACB continued to develop, issues related to each of the AEGIS core elements were investigated and potential solutions were proposed. While the team desires to see every solution implemented, the Program Manager is the final authority in determining which solutions are to be pursued. The Program Manager must find the funding for issue resolution and is in the best position to evaluate trade-offs between options. Based upon past experience of the R2D2 ACB, the Program Manager is not deciding between which data dictionary and data recording issues that should be funded. Rather, the decision is between data dictionary and data recording issues versus issues in other areas such as software code fixes or documentation. While the R2D2 ACB has had some significant accomplishments, change will be required if it is to continue growing into the future and increase the value that it can add to programs.

B. KEY POINTS AND RECOMMENDATIONS

Overall, the R2D2 ACB has been successful in its efforts supporting the AEGIS program. Participation has included most of the stakeholders in the AEGIS community who receive recorded data and rely on that data to perform systems engineering analysis. The key recommendations are:

1. **R2D2 ACB lacks direct funding.** The R2D2 ACB lacks authority through funding mechanisms to prioritize problems in data dictionaries and data

recording. Until data dictionary and data recording is specifically written into the acquisition contracts and direct funding is attached, it will remain vulnerable and expendable.

2. Membership stability. When data recording is not viewed as a high priority, the participation is inconsistent. Personnel turnover is inevitable in any program but the transition often does not encompass R2D2 responsibilities. The result is a loss of participation from some activities.

3. Issues found during or after formal acceptance testing. CSSQT testing is a critical event in the delivery of the AWS for introduction to the fleet or preparation for DT and/or OT. It has been common to have many unknowns in the data recording capabilities entering these tests. During the USS Winston S. Churchill (DDG-81) CSSQT, the analysis team noted 24 weapon system performance analysis issues of which 7 issues were related to data dictionaries and data recording. With uncertainties in the capability of the data dictionaries and data recording, necessary data could be lost or not available resulting in the inability to characterize the system performed. A critical part of the CSSQT testing is to allow Test Objectives to be answered to characterize critical functionality with the AWS. This would hinder the productivity of the CSSQT and possibly leave many Test Objectives unanswered simply because of data recording deficiencies that may have been easily remedied prior to the testing.

4. Collaborative Analysis. The R2D2 ACB allows the analysis community to bring data dictionary and data recording issues to the table that may have otherwise gone undiscovered during formal acceptance testing such as system demonstration tests. Working together, as the R2D2 ACB identifies an issue, the analysis community can understand and find solutions to help mitigate or resolve the issue. The collaboration has proven to be more effective than having each activity analyze issues independently. With the complexity of military systems, a collaborative approach will be essential in the future as it is unlikely that a single person or group will be able to evaluate system

performance. The R2D2 ACB provides the opportunity to bring together a focused group of experts capable of determining the data dictionary and data recording requirements to support the entire analysis community. Loss of the R2D2 ACB would likely result in a return to inconsistent analysis methods across system elements and activities. It is the membership that has made the R2D2 ACB strong and viable.

5. Closed Loop Systems Engineering Process. The R2D2 ACB has been a part of the closed loop systems engineering process that the AEGIS program has implemented. While the AEGIS program has only been able to achieve a partial implementation of the closed loop systems engineering process, R2D2 ACB can serve as the catalyst in continuing the closed loop systems engineering process into other combat weapon system platforms as the AEGIS program completes the baseline development efforts.

By introducing the R2D2 ACB into the program at the initial design stages, the potential for significant reductions in data dictionary and data recording rework efforts exists. Data recording can help to produce a higher quality software product by assisting the development effort. A robust and effective data recording capability allows software rework to be objectively assessed and assists the developer in determining if software rework has caused inadvertent changes in the computer program performance. The experience of the R2D2 ACB in the AEGIS program has demonstrated that a significant number of problems continue to exist beyond the rework to the AEGIS computer program that has already been done.

6. Early Introduction in System Development.

From the survey results, the general consensus is that the R2D2 ACB can provide great benefit and be very effective for a new weapon system program. However, it is critical to be involved early when the system is designed to ensure that the requirements in the system design include the infrastructure necessary to capture the data necessary to characterize system performance. Data recording is actually an important part of ensuring that a system will be

supportable. The information on system performance that is provided by data recording and reduction can provide evidence of system deficiencies and reliability, maintenance and availability. In fact, as testing for events such as early operational assessments are integrated into program schedules, the effectiveness of the R2D2 ACB will increase. Early involvement applies to existing systems that are being upgraded as well. As the next generation of data recording is created within the AEGIS Open Architecture design, the R2D2 ACB will need to be involved in the definition and implementation of the data dictionary and data recording formats as they are designed.

C. POTENTIAL AREAS FOR FUTURE RESEARCH

Many areas exist for future research on this topic. Since this study has been limited to combat weapon systems within the Navy, future research could pursue the applicability of the R2D2 ACB to weapon systems in other branches of the military service. Additionally, programs that rely on mission critical systems such as the Air Traffic Control Systems of the Federal Aviation Administration (FAA) and the Space Shuttle Program of the National Aeronautics and Space Administration (NASA) are candidates for future research as well.

D. CLOSING REMARKS

The results of the survey indicate that the R2D2 ACB can provide value to a weapon system program but value is not the only criteria that a Program Manager must consider. Two additional considerations are whether the R2D2 ACB aligns with the Defense Transformation efforts underway and will it reduce risk to the program in a concurrent development environment. For the Defense Transformation efforts, this analysis will focus on the transformation as provided in SEA POWER 21. As the Navy moves toward Network Centric Warfare, the data shared and transferred among systems will become more critical than in

previous generations of combat weapon systems. Another consideration is in the area of concurrent system development. Concurrent system development results in early operational assessment of system performance. As formal system testing is conducted earlier in the system development, the capability to assess system performance is being required earlier in the system development. Data recording and reduction provide the objective evidence to establish system design maturity and document operational issues in system performance. The R2D2 ACB has demonstrated that it will provide value to the Program Manager by prioritizing data recording and reduction capability requirements allowing the Program Manager to trade-off value added among competing priorities.

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APPENDIX A.

A. TOR FORM

To: LMSD SSAWCS
 c/o Computer Sciences Corporation
 Aegis Configuration Management Office
 P.O. Box N, Moorestown, NJ 08057

CONFIGURATION MANAGEMENT INFO. Page 1

Date	1. TOR Log	2. TOR Number
		T

ORIGINATOR INFORMATION (Required)

3. Originator Name		4. Organization <input type="checkbox"/> LM SysEng <input type="checkbox"/> CSC <input type="checkbox"/> LM CPP <input type="checkbox"/> NSWC <input type="checkbox"/> LM S/W Dev. <input type="checkbox"/> CMU	5. System Element <input type="checkbox"/> RAYTHEON <input type="checkbox"/> TECHREP <input type="checkbox"/> ATT
			6. Date Observed
7. Return Address		8. Program Identification/Loadfile	9. Baseline 7P1
10.	11.	12. Test Site (where observed) <input type="checkbox"/> Desk Check <input type="checkbox"/> PGC <input type="checkbox"/> CPTS <input type="checkbox"/> CSEDS <input type="checkbox"/> MEIT <input type="checkbox"/> System Level Eng. Tests (ISEs, Stress, Endurance, etc.) <input type="checkbox"/> SQT/EQT <input type="checkbox"/> Element Int. <input type="checkbox"/> CSIT <input type="checkbox"/> PTC Checkout/Production Acceptance Test <input type="checkbox"/> Shipboard <input type="checkbox"/> Dev/SE Checkout <input type="checkbox"/> ET&E <input type="checkbox"/> Formal Demos, DTs/OTs,etc.	<input type="checkbox"/> ACSC (Wallops Island) <input type="checkbox"/> PTC
13. Test type <input type="checkbox"/> Shipyard Checkout <input type="checkbox"/> Dev/SE Checkout			
Operation			

ORIGINATOR INFORMATION (As applicable)

14. Test Environment	15. Test Procedure Used Script S _____ Step _____ D _____ P _____	16. Dump/Recorded Data Tape Nos.: T _____ Dump D _____ Data D _____
17. Documentation Affected	18. Module/Function Affected	19. Site Log No.
19a. ITT Cross Reference	19b. Japan CPCR Number	20. Associated TDR

ORIGINATOR OBSERVATION (Required)

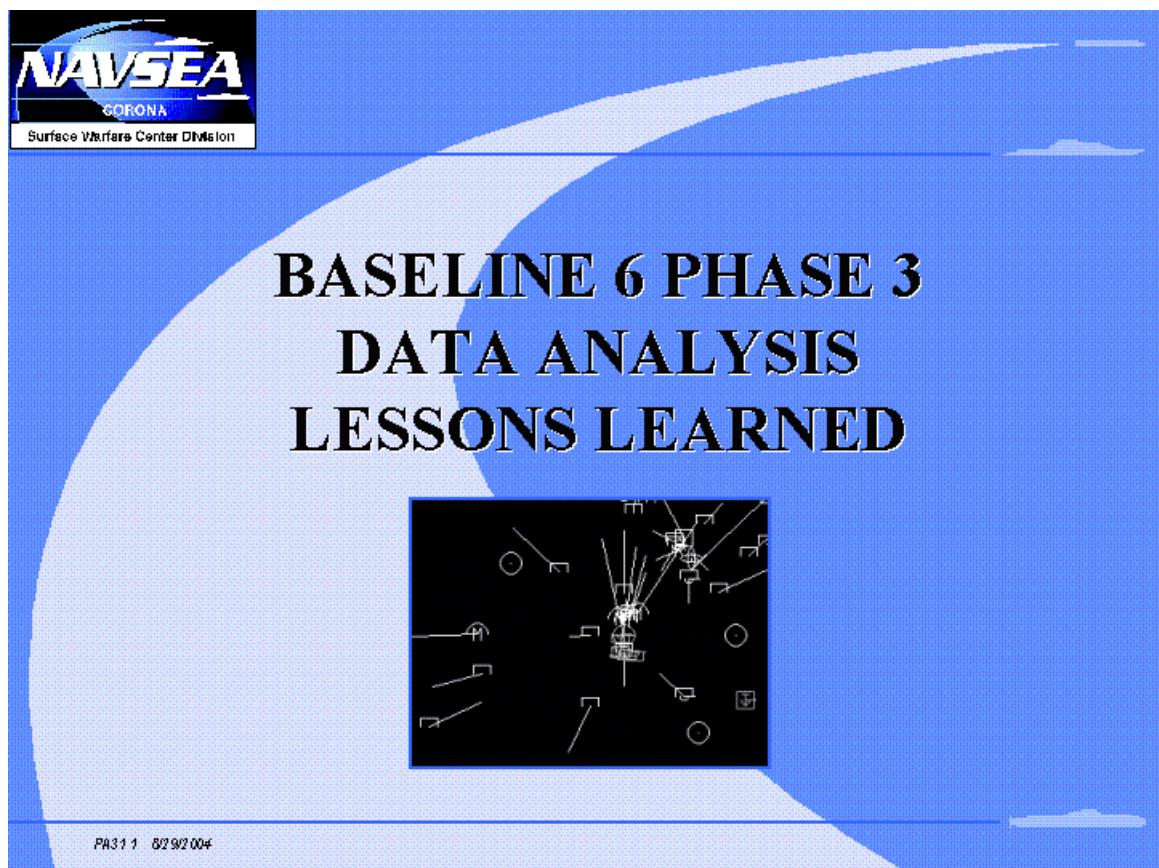
21. Short Title (Reflective of Observation)	
22. Description of Observation, GMT (if applicable), and other comments (Unclassified Information only)	
Attachment <input type="checkbox"/>	
23. Effect on System Element when observation described occurs and additional System Engineering comments (if applicable). (If recommended operational priority is 3, describe workaround.)	
Pri Sec.	Check one of each or N/A: Recommended 1679A Operational <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 Recommended Operational <input type="checkbox"/> A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/> E
24. Local Problem Report (LPR) Determination	

- a. QA Load/CTL? YES NO If yes, do not
b. If no:
 Problem in new development code? YES NO
c. If b is yes, identify # of CRCR that
 and treat TOR as an LPR

25. CPCR# (For non-LPRs)	SIB Pri CPCR Sub
-----------------------------	---------------------

APPENDIX B

A. EXAMPLE PRESENTATION FOR R2D2 ACB





PURPOSE

- Preparing for CSSQT
 - CSEDS Testing
 - Analysis Tools
 - Dahlgen Test Team Support
 - Shipyard and beyond
- CSSQT Lessons Learned
 - Event Example
 - Data Quantities
 - Tools
 - Timelines
- Have we learned our lessons?

PA312 8292004



Preparing for CSSQT

CSEDS Testing

- In Baseline 6 Phase 3, it became apparent very early on that the status quo was not going to work. Experience with Adjunct data from 6 phase 1 drove us to CSEDS.
- Functions at CSEDS: Tool development and debugging, system knowledge, interfacing with design agent, DEMO testing support in DTD analysis and verification. DEMO testing is more than SPY analysis.
- Analysis experience with CSSQT Dry Runs! Testing of tools with data that is as comparable to real life as can be achieved in a lab setting.

Without the knowledge and analysis process and tool development, the completion of event reconstruction of the 6 Phase 3 CSSQTs would not have been very successful



Analysis Tools

Analysis Tools required more effort than expected

- Configuration Management has been implemented
 - Challenges still continue in the trade-off between responsiveness versus control
- CSEDS testing provided some structured testing and in some instances the ability to redo some things.
 - Trying to redo things at CSSQT is expensive and often just can't be done
 - Written procedure makes it much easier to verify analysis tool performance

Lack of CEC integration during the CSEDS tests resulted in some unexpected tool deficiencies

PA314 8292004



CSSQT Example

**USS SHOUP (DDG 86) CSSQT
Live Fire Event A23 - D8602**

PA315 8292004

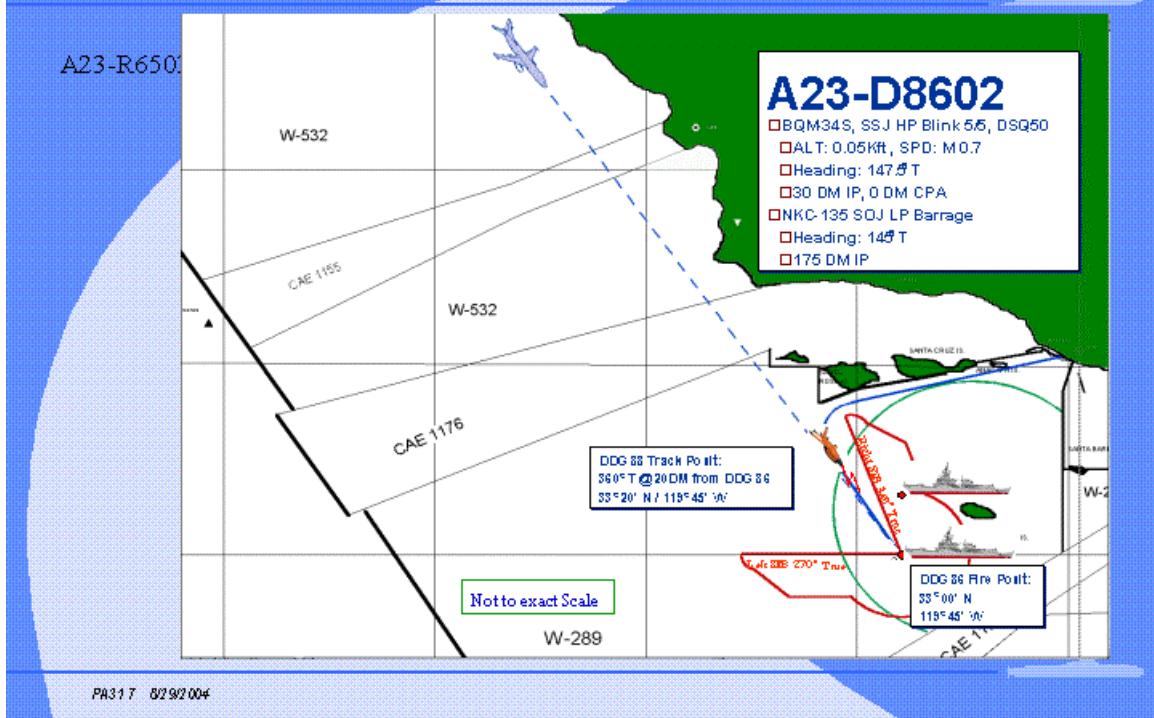


Evaluation Criteria For Surface Missile System (SMS) Performance

- NAVSEA INSTRUCTION C8820.1
 - To provide criteria for assessing SMS combat systems performance during AAW non-combat firing operations. This criteria provides the measure for assessing performance against air and surface targets, consistent with realistically observed data.
- The Criteria
 - Combat system performance during a target presentation consists of three phases
 - Surveillance Phase
 - Target Engagement Phase
 - Missile firing Phase
- AWS Test Objectives
 - Primary – 226
 - Secondary – 58, 302, 441

PA316 8292004

A23-D8602



How It Will Be Scored

One Presentation

One Target

Demonstrate Depth Of Fire

**Coverage Area
TO-226 Primary**

Complies With C8820.1
Two Primary TO's Can Work

BQM



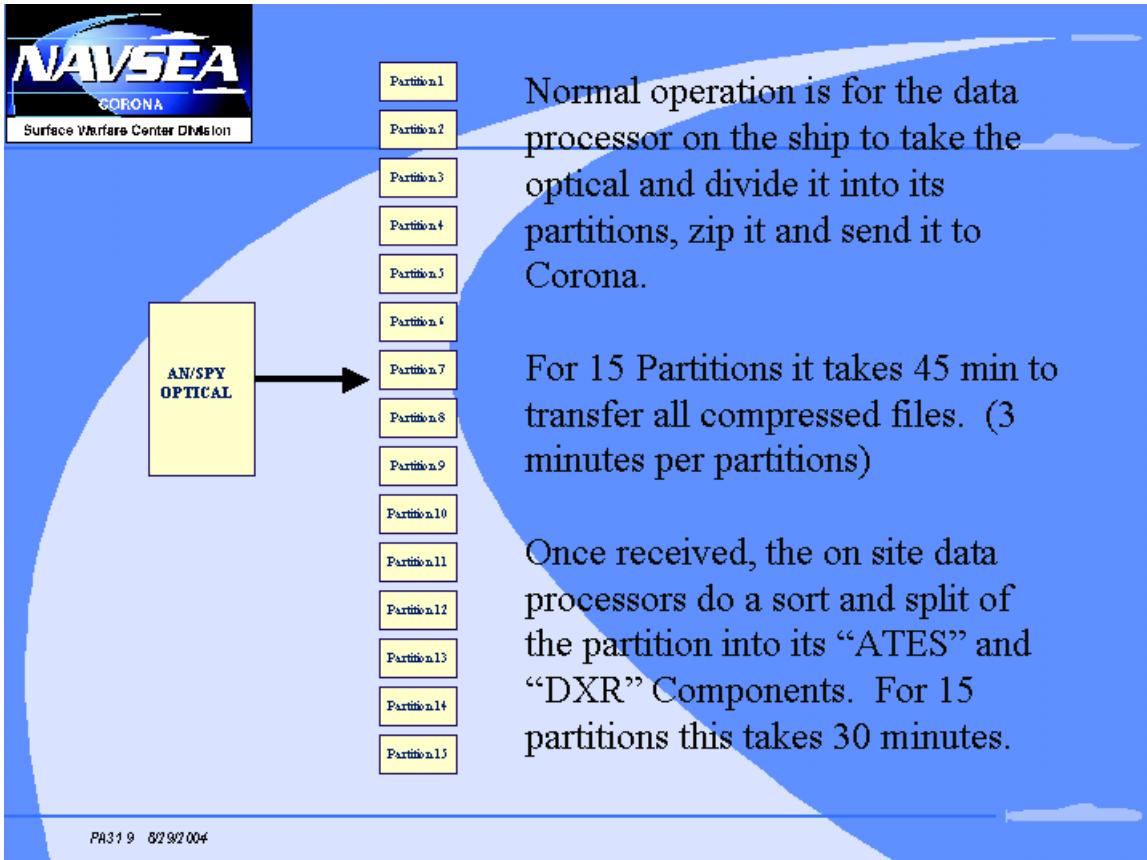
NKC

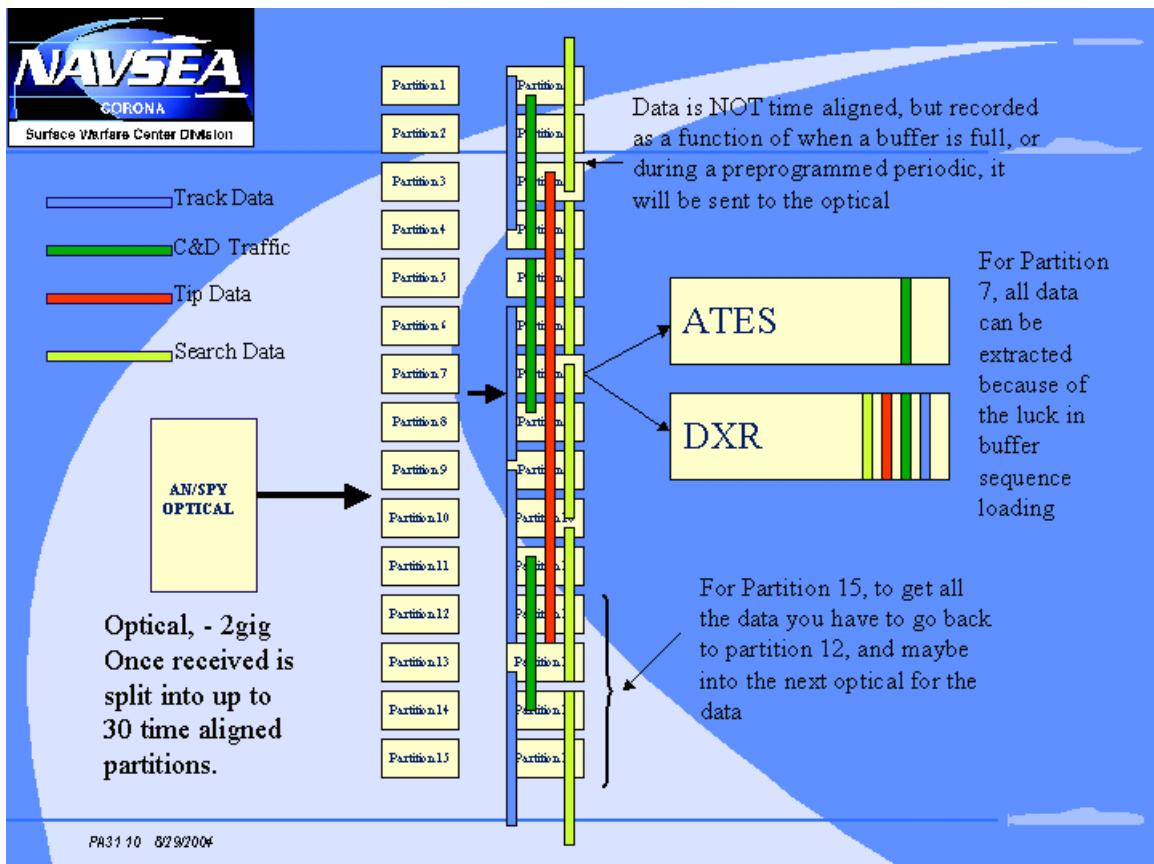


DDG-88

**Coverage Area
TO-441 Primary**

PA31 6 8292004







What it takes

- For every hour of testing in manned raids, it takes 4 hours
 - To get the data here,
 - Process the data,
 - Evaluate the test objectives,
 - Put together the report
- CEC data is a critical player in every event. Remote CEP data is the driving source of most engagements. Every live fire engagement for the recent 86/88 CSSQT had CEC data in it
- DXR data is cumbersome to go through. Measured in GB instead of MB!
- Limitations still exist
 - We have no clues as to what happening on the LAN
 - Adjunct switching and reconfiguration is not recorded

Since DDG-85, data prep time required for event analysis has doubled and in SPY and C&D tripled.

PAS111 0292004



Lessons Learned?

- We will be doing BASELINE-7
 - All COTS.....
 - Optical's are 5 GB, twice the capacity as 6 Ph III
 - New Programs
 - All DXR data
 - All new Hardware with increased performance capability. The big Littoral radar system
- Anticipate more analysis time than with the 6 Ph III ships

**The key to success is early, sustained effort
wherever the opportunities exist**

**Teaming with TECHREP, NGIT, Dahlgren, LM
and all other stakeholders**

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